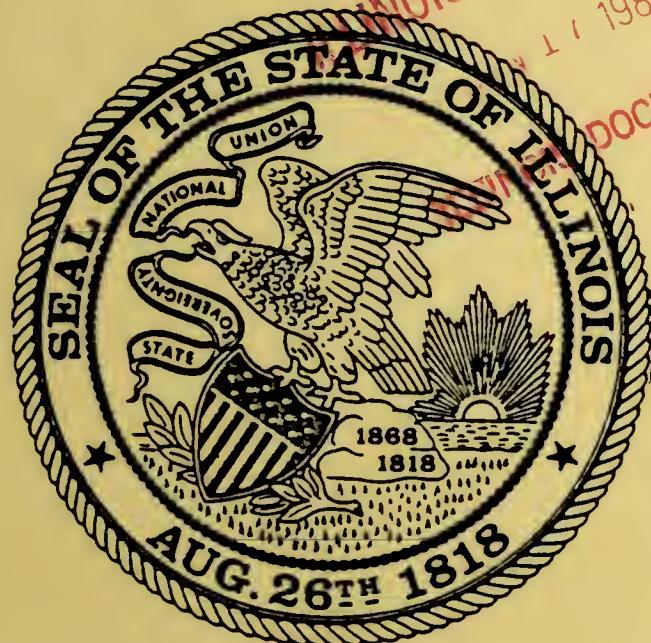


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ewide Feasibility Study of Ethanol from Biomass in Illinois



State of Illinois
PL 96-126 Proposal
Resource/Technology Area

I. Biomass
Volume One — Technical Proposal

Frank Beal, Director

Illinois Institute of
Natural
Resources



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JAMES R. THOMPSON
GOVERNOR

18 April 1980

Commander Larry Lukens
Office of Procurement Operations
U.S. Department of Energy
400 First Street, NW
Washington, DC 20585

Dear Commander Lukens:

On behalf of the State of Illinois, I am pleased to introduce, transmit and support this proposal entitled "Statewide Feasibility Study of Ethanol from Biomass in Illinois", in response to PL 96-126, Feasibility Studies Solicitation for Alternative Fuels Production. Illinois is committed to an active role in the commercialization of alternative fuel development within our State. Our abundant agricultural and coal resources are an excellent foundation for rapid development of alternative fuel industries to meet state, regional and national energy needs. It is important that the State participate in the coordination of activities leading the development and siting of commercial scale biomass-derived ethanol facilities within Illinois, to insure proper planning and policy development will occur.

The biomass-derived fuels or ethanol-from-corn feasibility study will focus on markets for feedstocks and products of ethanol production rather than exclusively on siting. Set into the context of the technical and economic constraints of ethanol production, the market analysis will provide the necessary data base for determining optional siting of new facilities within the State. A State policy element will be included to determine administrative, regulatory, or legislative actions which can assist marketing and production of ethanol in Illinois. These study areas are based upon our analysis of the major factors presently inhibiting or threatening ethanol production in Illinois. A basic component of the proposed analysis is a comprehensive, detailed marketing and policy plan to allow industry to move more readily into ethanol production.

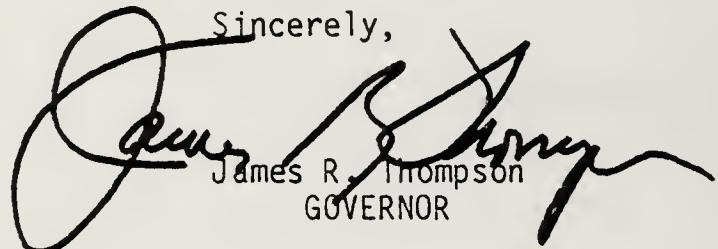


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I believe the proposal developed by the Illinois Institute of Natural Resources, the energy agency of our State, is an outstanding and timely proposal. It will provide the necessary economic marketing, and resource and environmental assessment to assist industry in siting and construction of commercial scale fuel ethanol facilities within the State of Illinois. We trust that the U.S. Department of Energy will also recognize the merits of Illinois' proposal and award a grant from the biomass category of the Solicitation Notice to the Illinois Institute of Natural Resources.

Sincerely,

James R. Thompson
GOVERNOR

A handwritten signature in black ink, appearing to read "James R. Thompson", is written over the printed title "GOVERNOR". The signature is fluid and cursive.

AMENDMENT RECEIPT ACKNOWLEDGEMENT

This will serve to acknowledge the receipt of amendments numbered 001, 002, 003, and 004 (dated 3/7/80, 3/26/80, and 4/10/80, 4/11/80) to the solicitation number DE-PA01-80RA50185.

George J. Benda Jr.

George J. Benda, Jr.

Manager, Energy Bond Fund Program
Illinois Institute of Natural Resources

4/23/80

Date

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ABSTRACT

The State of Illinois proposes to conduct a series of site specific feasibility studies for the commercial production of anhydrous ethanol from biomass. Feedstocks will be limited to grain and intermediates normally present at agriprocessing plants in the state.

Due to the sensitivity of this process's economic feasibility to feedstock and byproduct prices, and the volatile nature of these markets, meaningful assessment of any commercial scale facility requires accurate information on overall market activity. Based on this feature of the market, and on geographic and transportation concerns, an overall feasibility assessment, site screening, and location study will be conducted prior to the initiation of several site specific feasibility studies. These studies will rely to a great extent on work to date.

During the conduct of overall feasibility and site screening, an industrial steering committee will guide the work and structure a process for selection of corporate sponsors for site specific intensive study. Using this process, sponsors will be selected for the sites and plant scales which appear most promising.

Intensive engineering, financial, and environmental analysis will be conducted at the site specific level in sufficient detail to allow sponsors decisions on site aquisition, final design, financing and construction, and the committment of State financing assistance as may be deemed appropriate. While the content of such studies must be left in some measure to the sponsor's desires, each will include at minimum the analyses proposed in our work plan. Among the more important of these are;

- A cash flow - internal rate of return analysis for the projects' development, start up, and operation which explicitly and quantitatively reflects market risks and production incentives due to federal and state policies.

- An environmental baseline survey and selective environmental assessment, geared to key impacts in input and byproduct markets, air emissions from coal energy input, liquid waste treatment, and plant safety.

The proposed feasibility studies would be conducted by a combination of Institute of Natural Resources staff, a feasibility, siting and environmental consultant, a technology assessment and engineering consultant, and technical staff from corporate sponsors. Key management roles will be vested in the INR, the Industrial Steering Committee, and individual corporate sponsors. The proposed study timeframe is for a maximum duration of 18 months from grant award, with the last 10 months devoted to intensive site specific work.

BACKGROUND

Introduction

The State of Illinois has long recognized the need to develop technologies and commercial production facilities for the development of alternative fuel resources. Since 1974, the State of Illinois has worked closely with Federal energy agencies, most recently the U.S. Department of Energy, to develop a program which will help supply the nation with critically needed liquid and gaseous fuels.

It is widely recognized that the shortage of fuel resources currently faced in the United States is not a transient affair. Illinois recognizes the need to depend less upon foreign sources of energy, and to develop the resources available within our own borders. With the passage of the Illinois Coal and Energy Development Bond Act in 1974, the State of Illinois embarked upon its journey to a better energy future. Through the vehicle of the funding provided in the Bond Act, the Illinois Institute of Natural Resources (INR) is pursuing a variety of efforts to develop both coal-derived and renewable resource derived fuels.

Based on considerations of the resource base in Illinois, the current state of technological development, and end-use product suitability considerations, a subset of biomass technologies has been selected for a Statewide feasibility study. Technology to be studied includes producing anhydrous ethanol directly from feed grains or in conjunction with agricultural processing industries existing in the State.

This technology has been studied quite extensively at both the national and site specific levels, and is currently the subject of intense interest and activity. Two key facts for the national fuels ethanol from biomass perspective at the current time are;

- Current production costs and tax incentives make commercial scale production of fuels ethanol economically viable. Such

production is occurring at several facilities and many more are in the planning, design, or construction stages.

- Production of fuel ethanol in quantities sufficient to make large impacts on the national motor fuels picture would require quantities of feedstock sufficient to raise feedstock prices for both ethanol producers and more conventional sources of demand.

These facts imply that the feasibility of any single fuels ethanol facility is not independent of the overall level of fuels ethanol production. Thus, the current proposal includes an assessment of probable overall production levels which will determine feedstock, product, and by-product prices to be used in a series of site specific feasibility studies.

Rationale for State Involvement

It is fully realized that the 'typical' offeror under this solicitation will be a corporate entity or group of potential investors. While this is the group that most ultimately undertake commercialization, it is strongly felt that the most rapid method of economic and environmentally sound commercialization includes a central and early role for state government. This proposal, and the Illinois Institute of Natural Resources itself, are founded on this philosophy. Among the key facts supporting this rationale are;

- Coordinated studies of fuel ethanol production from biomass will include a consistent and realistic set of future price assumptions for feedstock and byproducts, based on an overall market assessment. Independent feasibility efforts would typically utilize current prices, or, if using overall market forecasts, would result in inconsistency and duplication.

- Coordinated site specific feasibility studies based on a simultaneous assessment of geographic market interacations will result in a realistic distribution of capacity with respect to feedstock production and byproduct consumption.
- An environmentally based site selection process, followed by direct involvement of all major permitting agencies in an advisory role, will streamline environmental permitting processes and reduce time requirements for implementation.
- The inclusion of alternate technology assessment on a comparable basis will furnish a wider choice of technological options at the initiation of site specific studies, and will foster development of favorable liquid fuels balance by emphasis on use of coal derived energy input.
- Consistency and comparability of feasibility economics among sites will allow for faster "site switching" for potential sponsors and provide clearer input for formulating state incentives.
- The proposed process provides for assessment of nonsite specific environmental impacts, including price effects in food markets, increased crop production and potential increased erosion, and product market distribution system impacts. These impacts cannot be systematically addressed in the context of individual site specific studies.
- The current "free market" process for fuel ethanol is producing two distinct production trends, both of which are inconsistent with PL 96-126 goals. First, commercial scale production is occurring primarily at wet milling plants utilizing natural gas as an energy input medium, thus creating an unfavorable fuels balance. Second, much labor and

some capital is being expended in very small scale ethanol facilities, which suffer from high unit costs and potential safety risks.

Resource Base and Process Suitability

The use of feed grains, including corn, for the production of alcohol through fermentation and distillation is an age-old process. In simplest terms, the suitability of a biomass resource base for ethanol production is determined by the potential abundance, location, and chemical characteristics of the feedstock. Corn, or other feedstocks characteristic of corn processing operations are rated favorably on all these criteria.

Corn is an abundant resource in the state, with a production technology already in place and capable of sustaining a significantly higher level of production in the long-term than is currently maintained. Illinois is in a particularly favorable location among corn producing states, close to several demand centers for motor fuels, major bulk transportation centers, and currently producing approximately 20 percent of the nation's corn crop.

The chemical characteristics of corn or corn processing intermediates as ethanol feedstocks are excellent. The starch content of the grain is relatively high, and its cellulose content is minimal. The physical properties of the grain make for fairly easy transportation and storage technology. Another factor which makes production of fuels ethanol by fermentation distillation technologies particularly suitable for the resource base in Illinois is that distiller's dried grains and solubles are produced as a by-product.

This by-product makes an excellent high protein supplemental feed for livestock, which is also produced in significant quantity in the State. This combination of location near the product, by-product,

and feedstock markets implies an almost ideal suitability of the process to the resource base. In short, if production of fuel ethanol from feed grains is an economically viable process anywhere in the nation, it will certainly be so in Illinois.

General Technical Viability

The technical viability of the fermentation-distillation process for anhydrous ethanol production is excellent. This process has been in use in its complete form (including breaking of the azeotropic bond) for at least 50 years. Process input requirements are simple, including corn or other feedstock, cooling and process water of at least 25 gallons per gallon of product, enzymes for cooking and fermentation, benzene or another azeotrope-breaking stripping agent for the final step in anhydrous production, and an energy input source of some sort for cooking, distillation, and drying of by-product grains. Among potential modifications that may be made to this baseline fermentation distillation process to allow more energy efficient and economic application are the following:

- Inclusion of direct coal-fired energy input sources rather than the natural gas source that is typically used in existing ethanol production and agricultural processing operations.
- Utilization of so-called "waste heat" from power plants or other major coal-fired boilers.
- Substitution of another compound or compounds for use in the azeotrope-breaking stage, thus circumventing any potential problems with the carcinogenic properties of benzene.
- Refinements in the liquid waste treatment technology currently utilized for ethanol production facilities and agricultural processing plants.

While these technological refinements will allow a more environmentally sound, energy efficient, or economic application of the technology, it is emphasized that they are engineering modifications and not "R & D" efforts required to assure the technical viability of the process. Existing technology and engineering design can be applied to all of these areas.

General Economic Viability

Both research studies and observation of the current activity in fuels ethanol production indicate that it is economically feasible with existing tax incentives at the Federal and state levels. In the past two years, at least nine facilities have come on line (or been converted from agricultural processing applications), to produce anhydrous ethanol for mixture with gasoline in the "gasohol" market. At the same time, studies of the fuel market on the national scale have indicated that production of anhydrous ethanol in quantities sufficient to displace 10 percent of our current gasoline consumption, would require an increase of over 50 percent in corn production (at existing yield figures). This simple technological fact, combined with the fact that the supply for corn has been demonstrated to be noticeably elastic (increased quantities will come forth on the market only with significant increases in prices) indicates that the growth of the fuels ethanol industry from feed grains will, in all likelihood, be a self-limiting phenomenon. One of the key tenants of this proposal is that the economic viability of any single proposed ethanol production facility cannot be meaningfully determined without some systematic prior assessment of the likely market prices that will prevail for feedstock, product, and by-product in the national market. Thus, this proposal includes a general feasibility studies element which will determine probable scenarios for these key input parameters to site specific feasibility studies.

FEASIBILITY STUDY APPROACH

Introduction & Objectives

The current proposal is in response to both the immediate PL 92-126 feasibility study goals, and the long-term economic and environmental interests of the State of Illinois. As such, the study represents some departures from the sample DOE work program, which is (at least implicitly) focused on a single fuels production facility and geographic site. Thus, the work program outlined here is first addressed to the broad issues of technology, and state economic and environmental concerns, but is designed to focus quickly on the appropriate sites, technologies, plant scales, and organizational considerations that are appropriate in light of these concerns, and identification of the particular actions required for the near term implementation of this technology in Illinois.

This proposal is submitted for partial DOE funding, with the balance of feasibility study costs to be borne by the state. This reflects the mix of federal and state goals and concerns to be addressed. While no single corporate interest is associated with the conduct of this study, several have expressed interest in possible informational and policy input, and among basic goals is to identify those corporate entities with significant interest in biomass conversion in the state, and to outline specific action steps for construction and production. The proposed level of corporate involvement includes company specific financial analysis in sufficient detail to support investment decisions. This integrated public/private sector approach is designed to reduce the perception of risk in the private sector and to minimize the total time required for commercially significant production.

The remainder of this section addresses the details of technical approach, organized in eight major task groups:

1. Technology Survey and Documentation
2. Overall Feasibility Studies

3. Preliminary Site Screening
4. Plant Scale Optimization Studies
5. Financial Capability and Market Organization Studies
6. Plant Location Studies
7. Site Specific Feasibility Studies
8. State Policy Studies

While these task groups differ somewhat from the six technical approach components illustrated in the Request for Proposal, all of the salient issues raised are addressed within the task groups as indicated below:

<u>RFP Component</u>	<u>Addressed in Task Group(s)</u>
Preliminary Facility Design	1, 4, 7
Economic and Financial Analysis	2, 5, 7, 8
Market Analysis	2, 7, 8
Siting Considerations	3, 6
Alternative Fuels Resource Assessments	1, 2
Environmental Assessment	3, 6, 7, 8

The tasks within each of these major task groups are illustrated in Figure 1, which displays work flow relations for the proposed study.

Study Schedule

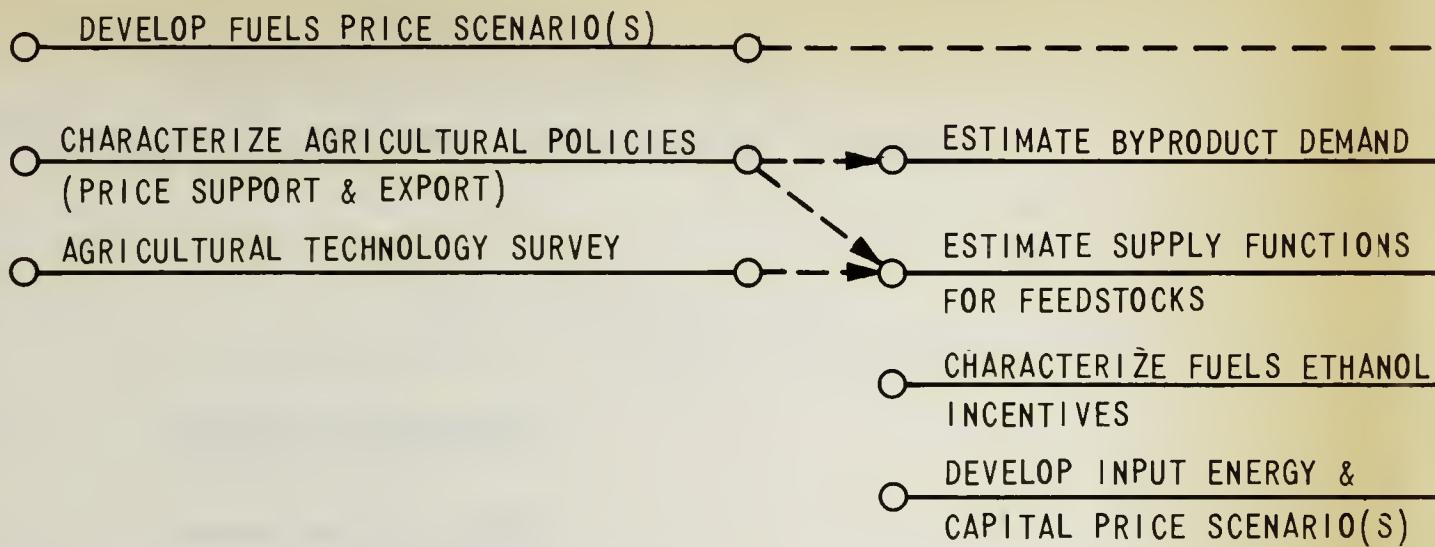
Figure 2 sets forth our proposed study schedule by major task group. This schedule calls for the completion of all site specific feasibility studies within eighteen months of grant award.

TASK GROUP 1, TECHNOLOGY SURVEY AND DOCUMENTATION

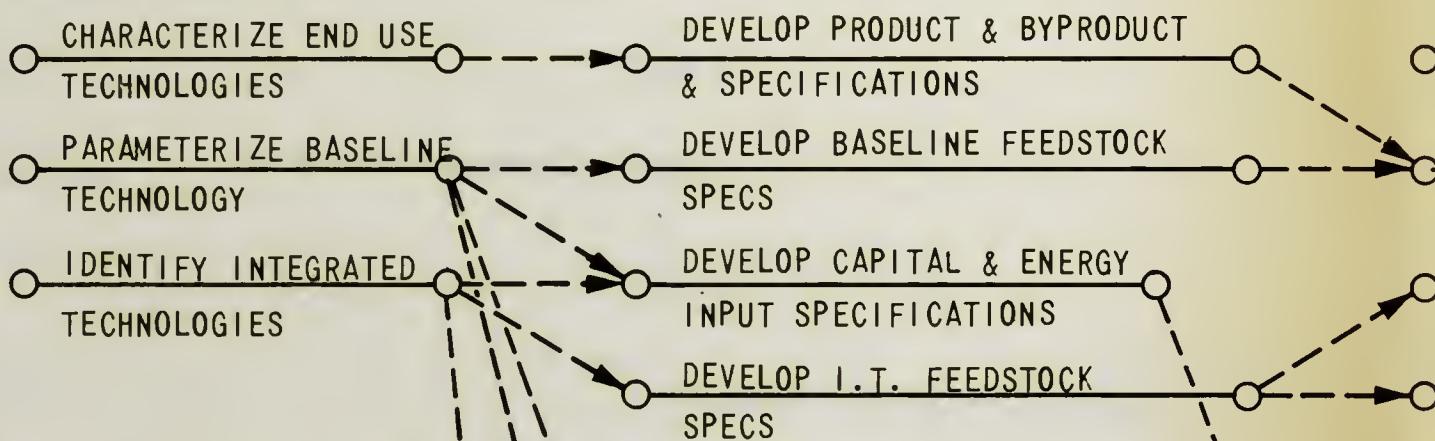
Introduction

Of the many possible fuels products from biomass, the most commercially feasible for immediate widespread application (in current end use technologies) is ethanol. In its anhydrous form, blending with gasoline produces a motor fuel with an octane rating higher than either of the "parent" fuels. While the long term economic viability of this

OVERALL FEASIBILITY STUDIES



TECHNOLOGY SURVEY & DOCUMENTATION



PRELIMINARY SITE SCREENING

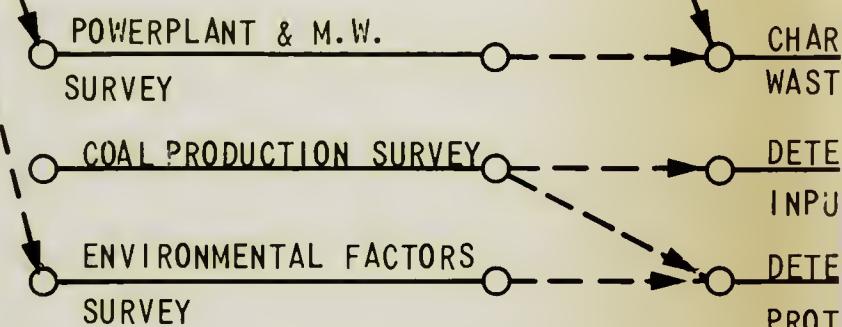
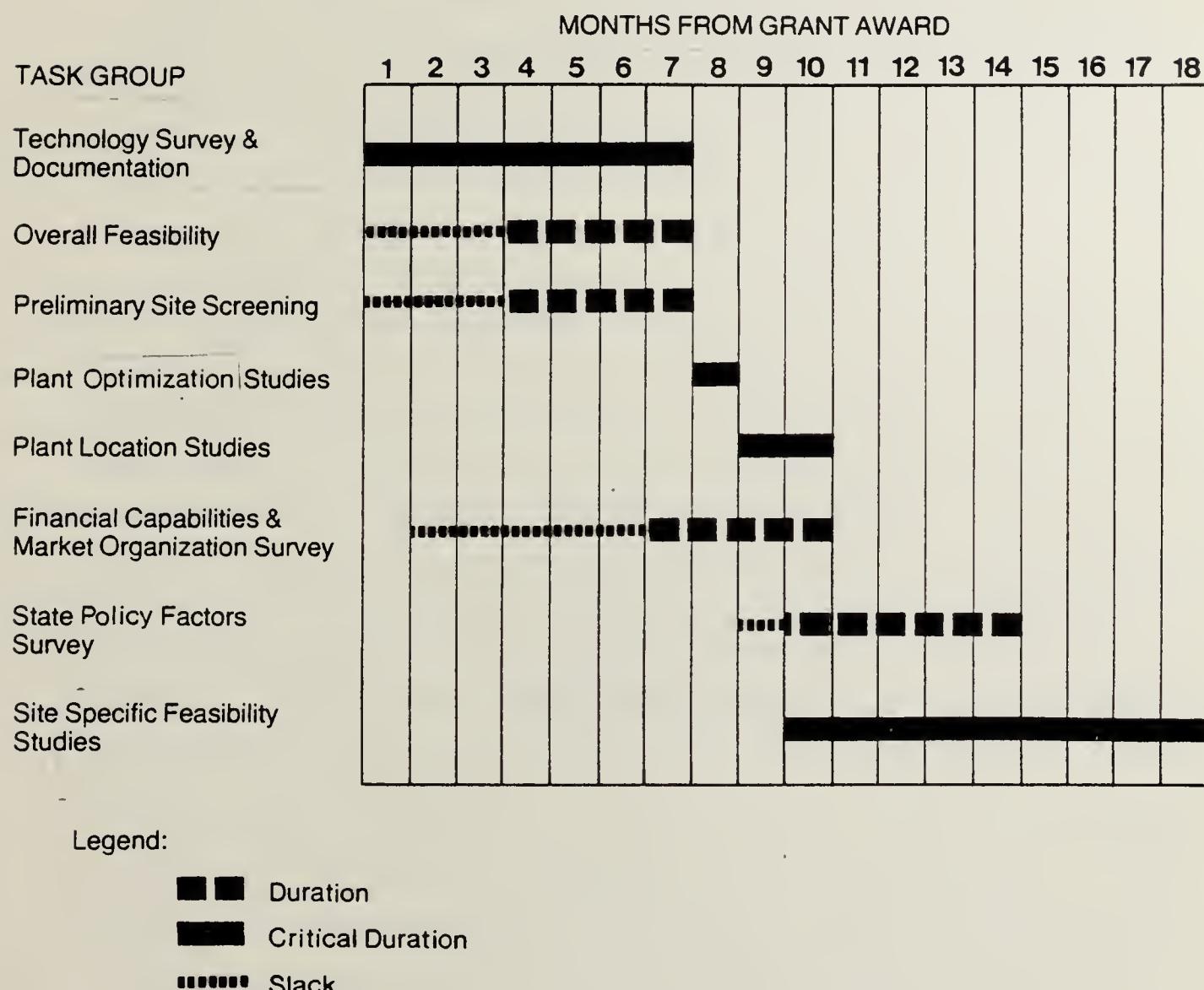


FIGURE 2
PROPOSED SCHEDULE
ETHANOL FROM BIOMASS FEASIBILITY STUDIES



"gasohol" fuel is a subject of considerable debate, it is the only alternative fuel being commercially produced and used at the current time and offers quicker prospect for near term availability.

Based on these advantages, a proven productivity technology, and the currency of ethonal production and tax incentives as policy issues in the Midwest, the proposed feasibility study centers on ethanol products to the exclusion of other biomass fuels. It is important to note that only anhydrous ethanol is within the scope of this study, and not experimental blends in which some water remains.

A fairly wide variety of production technologies can be used to derive ethanol from biomass, but most are variants of a fermentation-distillation process. The variations are based mostly on feedstock properties, energy inputs, and distillation approaches. In order to insure that relatively risk free and commercially viable processes are represented as the basis for feasibility determination, a specific subset has been defined for study. This technology set was defined in general terms in the previous section, and will be fully documented within this task group. The baseline production process for 190 proof production is two column fermentation-distillation. The conventional baseline technology for conversion of 190 proof to anhydrous is benzene stripping in a third column.

Two baseline feedstocks have been identified; shelled corn and wet milling (corn processing) intermediates. These feedstocks are potentially plentiful, and allow for existing agricultural production and processing technology to serve as feedstock supply technologies.

Possible variations on these feedstocks will be identified during the course of study, based in part on a study funded by IINR, and currently under way at Argonne National Laboratories, and in part based on input from Illinois food processing industries participating in the study. Feedstocks are specifically restricted, however, to starches or

sugars contained in either agricultural products produced in significant quantity in the state, or agriprocessing waste or process streams.

Technologies requiring cellulosic conversion are specifically excluded due to economic and technological uncertainties.

The baseline energy input sources are: 1) combustion of local coal, 2) synthetic liquids or gas from coal, or 3) waste heat produced at power generation facilities, industrial installations, or incineration facilities. Energy input from petro fuels or electric power for process heat are specifically excluded from the allowable technology set.

Work Plan

Since the basics of production technology have been defined prior to the feasibility study process, and since this technological set has been extensively studied in theory and practice, the "Preliminary Facility Design" task proposed is really more a matter of documentation and parameterization than design. Major points of emphasis during this task are discussed below.

Feedstock Specifications

Specifications for feedstock will be developed for both grains and agricultural processing wastes in terms of relevant physical-chemical parameters and quantities (for each scale of plant). Of particular importance to the ultimate commercial viability of ethanol production will be the definition of minimum quality standards for grain feedstocks. Many of the qualities requisite for feed grain may not be important for grain feedstocks, allowing cheaper production and lower input costs, through such techniques as reduced drying.

End Use Technology

Existing research on use of ethanol/gasoline mixtures will be summarized as it relates to specifications for product (ethanol) quality. No original research is proposed in the end use technology field. It is noted that only anhydrous ethanol, and not lower proof

products, will be considered, due to the phase separation problems inherent in the latter.

End use technologies for by-products will be investigated along several avenues. First, the potential for utilization of distillers grains in wet form will be studied. This investigation will address the key physical-chemical characteristics of the by-products under baseline and other techniques, and the resulting modifications of livestock feeding practices which would be required to utilize these products on a continual basis. Second, the end use technologies for by-products associated with wet milling and other agriprocessing will be documented as they relate to by-product specifications.

Product and By-Product Specifications

Based on research by others and the characterization of end use technologies, a comprehensive and consistent set of product and by-product specifications will be developed. These specifications will establish acceptable minimum and maximum values for the physical-chemical characteristics of fuel ethanol and all by-products of major commercial significance. These specifications will include all parameters which are of significance for production processes and costs, and will include at minimum the following parameters:

<u>Product or By-Product</u>	<u>Parameters</u>
Ethanol	Hydrocarbon Content
Distiller's Grains and Other Feeds	Protein Content Caloric Value Moisture Content Ash Content
Yeasts and Solubles	Protein Content

These product and by-product specifications will be used to insure standardization of feasibility analyses and comparisons among technologies and sites. The emphasis in this task will be on by-product quality, which is subject to greater variation than ethanol quality, and which has more important marketing implications.

Development of Capital and Energy Input Specifications

Much of the work to date on ethanol fuels feasibility has treated capital and energy input issues by assuming standard unit costs. Since the commercialization of fuel ethanol production, particularly on a large scale is subject to considerable uncertainty and risk from market sources, care needs to be taken to insure that the technology is responsive to these risks.

The primary considerations with regard to capital are quality, useful life, flexibility, and standardization. Although ethanol production via the technologies considered in this proposal is not considered capital intensive, the downside risks in commercialization may be regarded as roughly proportionate to investment, (based on the worst case risk of market collapse). Thus, any steps that can be taken to optimize the quality, design life, resale value, or potential for conversion to alternate uses of producer's capital goods will tend to minimize risk and promote commercialization. It is proposed that these issues be addressed in detail. The engineering portion of this task will investigate methods to minimize capital costs through standardization or lower design life than typically used, or to insure maximum resale value (or alternate use value) by tailoring ethanol production systems to specific types of wet milling or other food processing industries. The product of these studies will be a set of performance specifications for both baseline and integrated technology plants.

Process heat requirements will be defined based on the energy requirements of various unit processes in each technology. Consideration will be given to designs which allow use of low grade waste heat for preheating during cooking or distillation, or drying of grain by-products.

Develop Product and Feedstock Transportation Costs

Research to date has indicated that per unit production costs for fuels ethanol by "Baseline" technology (exclusive of transportation) decline rapidly as scale of plant increases from one to twenty million gallons per year, decline moderately from twenty to fifty million gallons per year, and decline very slowly above the fifty million gallons per year level. Thus, considerations of optimal plant size and market organization may, at large production scales, be dominated by transportation economics and irregularities in market densities.

The most complete study to date (DPRA) to consider transportation costs in a market organization context utilized a fairly simple "cost per ton mile" approach based on several market "densities." This proposal refines this approach in two significant ways. First, feedstock transportation cost estimates will be developed for specific (point to point) origins and destinations, assuming that only a portion of feedstock is available for ethanol production within a given county. Second, the transportation costs for both feedstock and product will be developed on a modal basis using explicit quantities geared to plant capacities.

The results of this task will be used in a generalized form in the plant scale optimization task group and in their detailed form during the Site Specific Feasibility Studies task group.

TASK GROUP 2, OVERALL FEASIBILITY AND MARKET STUDIES

Introduction

As noted in the Background Section, the major sources of uncertainty for biomass ethanol production are economic rather than technological or environmental. Thus, the market analysis aspects of this proposal are strongly emphasized. In addition to the obvious importance of product markets, feedstock markets are crucial to the feasibility and impact of ethanol production using the technology specified. Studies have indicated that fermentation-distillation technology feasibility is more sensitive to feedstock costs than any other single factor. In addition to this technological factor, market factors become important when nationally significant levels of ethanol production are considered. Current supply elasticities for corn have been estimated at .5-.6. Such relatively high elasticities imply that high levels of demand for grain feedstocks will result in market price increases which both damage the economic prospects for biomass ethanol and result in a "consumer's loss" for buyers of grain for feed purposes.

Product market considerations involve ethanol, distillers dried grains and soluble substitutes such as soybean meal, and other food products that are joint products with ethanol in integrated agriprocessing-ethanol operations.

The ethanol market is composed of several regional markets for anhydrous ethanol as a gasoline additive. The market for distillers dried grains and solubles is, at present, a fairly simple function of livestock production levels. Markets for joint products of (notably corn oil or sweeteners) of integrated agriprocessing-ethanol operations are more complex, depending more on substitution possibilities in production than final demand.

The technical approach set forth below is designed to capture the essential features of product and feedstock markets in a consistent economic framework without requiring substantial research effort.

Product Market

The current experience with gasohol, including both technical studies and consumer response, suggests that it is an almost perfect substitute for unleaded gasoline. This very high degree of substitutability, combined with the fact that even high levels of ethanol production contribute relatively small quantities to total fuels demand, imply that market demand for gasohol is accurately approximated by gasoline demand. In short, producers of ethanol for the gasohol market are price takers - their production will not influence motor fuels prices. Thus, estimation of market demand for ethanol used as a gasoline additive does not require additional analysis beyond the normal estimation of gasoline demand.

It is proposed that the future demand (e.g. prices) for motor fuels will be estimated for use in this study based on previous work with one of the major national energy/economic models (ETA-MACRO, BROOKHAVEN-DRI, or a similar model). Such price forecasts produced by integrated energy economic models reflect reasonable assumptions about increasing scarcity of petroleum based fuels and their impacts on economic growth, and are explicitly linked to forecasts of overall economic activity.

Thus, use of one of these models to provide a feasibility analysis baseline insures an internally consistent and reasonable Marco-economic and energy pricing framework.

Feedstock Markets

As previously indicated, the feedstock markets, and particularly the market for corn, will be very significant in determining economic feasibility of fuel ethanol production. The proposed study will utilize existing agricultural economic research to the highest degree possible in estimating time variable supply curves for feedstocks. These supply curves will reflect judgments about existing and probable future elasticities over the study time frame and will reflect explicit assumptions with regard to agricultural production technologies.

In addition to estimation of supply functions for feedstocks, demand for feedstocks from sources other than ethanol production will also be estimated. Once again, this estimation will be conducted to the extent practical in the context of a national energy and economic modeling framework (or the econometric component of such a model). This demand forecast will be adjusted as required to reflect United States export price support policies for feed grains. Explicit treatment of this component of demand will allow a segregation of the component of price which is due to government action rather than market demand. These analyses of demand and supply for feedstock will be combined to produce a base case feedstock price and production forecast for the time period of the analysis. In addition, analysis will be made to the degree to which price support programs are influencing the "market price" of corn during the analysis. This latter analysis will allow estimation of the "economic" price (or opportunity cost) of the feedstock for use in biomass fuels production.

By-Product Markets

The remaining market of major relevance to the assessment of biomass fuels feasibility in the State is the market for high protein livestock feeds and particularly soybean meal and distillers dried grains. Based on USDA and Illinois Department of Agriculture projection of livestock price and production for the future years, a market demand for high protein feedstocks will be estimated. Based on technical data concerning the limits on substitution of distillers dried grains for use as high protein livestock feed supplements will be developed.

In addition to these market factors, other major inputs to the overall determination of fuel ethanol feasibility will include a characterization of economic incentives for production and the development of energy input and capital pricing scenarios. The approaches proposed for each of these tasks are discussed below.

Production and Use

It is clear that the current production and use of ethanol as a motor fuel additive in the United States and the extensive and intensive interests in building more ethanol production capability at the current time has been generated in large measure by substantial tax incentives at both the Federal and state levels. Among these are the exemption of the ethanol-gasoline mixture, "gasohol" from the federal tax motor fuels tax of four cents per gallon and from several state level motor fuels or sales taxes which range from two to seven cents per gallon. In the most extreme case, this represents a subsidy of eleven cents per gallon of final product, which implies a subsidy of \$1.10

per gallon of ethanol produced. The creation of additional subsidies (by extension of the tax exemptions to other states or increases in the exemption in states which now have exemptions) will obviously create large additional interest and activity in fuel ethanol production.

While it can be argued that the true economic feasibility or viability of any production process should be studied in the absence of any government created incentives, two points are relevant here; first, the economic wisdom of the existing taxes have never been demonstrated. They are themselves government policy instruments and attempt to alter purely economic incentives. Second, and most importantly for the purposes of this proposal, these tax incentives on the part of the Federal government and other states are completely outside the policy control of the State of Illinois. Thus, they represent an exogenous force which will in the near future, to a large degree, determine the commercial viability of fuels ethanol production in the State. As such, these policies must be accounted for in forecasting the future viability for such production from the producers perspective.

In characterizing these fuels ethanol incentives, several possible scenarios will be developed, including:

- A "tax incentive expiration" scenario in which the current federal and state tax incentives were discontinued in 1992.
- A scenario in which fuels ethanol mixtures were exempt from only the four cents per gallon Federal tax.
- A continuation of the current tax incentive mix for the economic life of a typical facility.

Development of Energy and Capital Pricing Scenarios

In addition to the specific market and tax factors that will go into the overall feasibility determination, forecasts of more general economic parameters are also required. The two key factors in this regard will be the prices of energy and capital to be used in ethanol production. In order to achieve consistency in the feasibility study, it is proposed that these energy and capital price scenarios be developed from an existing integrated energy/economic modeling effort as outlined previously. These models furnish indices which will be converted to appropriate parametric forms for capital and energy input prices for use in the overall feasibility determination.

Overall Feasibility Determination

The overall feasibility determination for fuel ethanol production will be conducted in the context of a general equilibrium analysis, in which all the inputs discussed above are included in a systematic fashion. The primary feature of this approach is that different levels of production have differing degrees of impact on feedstock markets. In general, the higher the production level of fuels ethanol, the more total demand for feedstocks and the higher the feedstock price. (The more ethanol produced the more expensive it will be to produce the next marginal unit of the product.) A similar feedback phenomenon will occur with production of distiller's dried grains. The more produced, the more saturated the soybean and distiller's dried grain market will become and the lower price for the by-product. Both of these feedback mechanisms will be modeled in determining the economically feasible level of ethanol production. The key products from this analysis will be price forecasts for feedstocks and distiller's dried grains as by-products of the

conventional ethanol technology and projected equilibrium product prices and quantities. This general feasibility analysis will furnish a set of assumptions with regard to the key price parameters which will, in part, determine the economic feasibility of any single ethanol facility. As such, it is one of the cornerstones of the detailed (site specific) feasibility studies that will follow.

TASK GROUP 3, PRELIMINARY SITE SCREENING

Introduction

The basic goal of the proposed study is to move as rapidly as possible toward a set of consistent and comprehensive site specific feasibility studies for fuel ethanol production in the State. While the attainment of this goal depends on the results of market and technological studies outlined above, site specific factors play a major role in the final determination of individual commercial viability. Since the ethanol production technologies under consideration have already been studied, the site specific factors apt to be of primary importance have already been indentified. Among these are the potential for utilization of waste heat from existing utility or industrial sources, the ability to utilize coal as an energy input source, water supply and waste treatment considerations, special market proximity or density factors, and transportation factors.

In response to these considerations, the Preliminary Site Screening task group has been defined to be conducted in parallel with the Overall Feasibility Study and the Technology Survey and Documentation task groups. The major elements of the Preliminary Site Screening task group are discussed below.

Survey of Potential Waste Heat Sources

Technical studies to date have shown that conventional fuel ethanol production technology has a marginal or even slightly negative overall energy balance. By selection of an appropriate energy input source, however, the usable liquid

fuels balance of the process is substantially positive. If it is possible to go one step further and utilize so called "waste" heat, the marginal energy balance of the fuels ethanol production process may be made even more favorable. Based on the parameterization of baseline technology, a range of energy input requirements and specifications will have been developed for each baseline scale of plant benchmark. These data will be utilized to design a survey of potential waste heat sources in Illinois. As now envisioned, this survey would include at least all major existing (and currently designed) power plants and major industrial boilers (MFBI) in the state. This survey would be conducted through the use of both questionnaires and interviews, and would document the following information for each potential waste heat source:

- 1) The total quantity (BTU per year) available as waste heat from the facility.
- 2) The engineering characteristics of this waste heat. (e.g., steam pressures and temperatures available).
- 3) The reliability considerations involved with each potential waste heat source. (e.g., days per year of availability and variance in quantity and quality).
- 4) Construction required to effectively utilize waste heat.
- 5) Site constraints which would prohibit the effective use of the waste heat source.
- 6) Regulatory and financial considerations involved with utilization of waste heat.

This data will be utilized in refining the financial and economic analysis characteristics of both baseline and integrated technologies in the Site Specific Feasibility Studies task group.

Coal Production and Pricing Survey

Illinois coal production data will be used to quantify regional variation in the availability, heating quality, environmental characteristics, and probable price of coal for use as an energy input source for ethanol production. This task will be integrated closely with both the waste heat utilization survey and the proposed study of coal conversion siting in the state, and will focus on defining any significant regional or site specific variations in the overall cost of coal utilization in conventional biomass technology.

Environmental Factors Survey

Among the environmental factors which may lead to preference of one site over another for biomass ethanol production are air quality considerations and liquid waste treatment considerations. Based on the parameterization of technology requirements for each of these three categories will be developed for each benchmark scale of plant for the conventional technology. Existing environmental data will be screened utilizing these criteria to identify a set of regions within which the environmental holding capacity appears adequate for various scales of ethanol production facilities. The results of this environmental factors survey will then be integrated for particular sites identified in the waste heat and coal production surveys to determine site specific environmental protection costs.

Costs for air pollution control will be of major importance. Based on energy input requirements, heating values, and chemical characteristics of coals, the regulatory requirements for control technology will be identified for each potential site.

TASK GROUP 4, PLANT SCALE OPTIMIZATION STUDIES

Introduction

A key variable for siting is the number of production facilities required for a given level of demand. Both simple engineering estimates and more complete life cycle studies have indicated significant economies of scale for plants from 1 - 120 MG/Y. While no clear optimum size has been identified, it is obvious that very small conventional technology plants are not competitive with those in the 20 MG/Y + range.

While it is not proposed to conduct a complete reevaluation of the optimal plant size question, it is considered necessary to adjust existing results to reflect the following considerations:

- ° Energy Source

The potential for utilization of "waste" heat as an energy source could seriously affect plant scale questions. In order for waste heat utilization to be effectively incorporated in either existing or new coal fired power plants, steam demand must reach some minimum level. Thus, "optimal" sized plants utilizing this technology may very well be governed by this constraint. The potential for utilizing other waste heat sources will also be studied for smaller scale facilities.

- ° Feed Drying Requirements

The possibilities of considerable energy savings in ethanol production have been suggested if feed grain drying could be eliminated. (Approximately 1/2 of total process

energy is required for drying.) Based on the technology survey and documentation, cost impacts for this technology will be incorporated for plants of an appropriate size range. The feasible scale of plant for this type of facility will be limited by the area within which wet DDG can be hauled before spoiling, or the costs of handling the wet product.

- Transportation Economics

Existing optimization studies assume a "uniform" feedstock and product transportation process. The concentration of transportation facilities, and particularly intermodal transfer points at major storage facilities, could alter total costs significantly.

These adjustments to cost curves for baseline technology will be accomplished by disaggregation of life cycle costs to discrete capital and operating components, independent restimation of those line items mentioned above to reflect site specific variations, and incorporation in total cost curves.

For production of ethanol at wet milling and other agriprocessing operations, optimal ethanol production scale will be governed to large extent by plant scale considerations for the "parent" facility. For major integrated technologies such as wet milling, the question of plant scale optimization will be treated explicitly by a life cycle costing of combined plant, analogous to that utilized for the baseline technology. For integrated technologies with minor potential impact in terms of ethanol production quantities in the state, plant scale will be assumed to be determined solely by parent facility scale economics.

TASK GROUP 5, FINANCIAL CAPABILITIES AND MARKET ORGANIZATION SURVEY

Introduction

There is a substantial amount of current interest in the production of fuel ethanol at almost all scales of plant. While it is clear that with existing tax incentives and technologies, production of fuel ethanol is clearly feasible at some levels, it is also clear that there are a great deal of both capital and human resources being spent in the consideration and development of ethanol production facilities which (by ordinary engineering and economic criteria) seem to be completely infeasible. Thus, it appears that the financial capability and the market organization for feedstock, final product, and by-product will be crucial to the long term commercial viability. It is in response to these considerations that the current group of tasks have been formulated. Major elements of this task group are discussed below.

Survey of Existing Feedstock and By-Product Market Organizations

Since feedstock costs are crucial to the commercial viability of ethanol production, the market characteristics, concentration, and market power exhibited by feedstock producers are of crucial importance to the organization of a fuel ethanol industry. While it is the nature of the baseline ethanol production technology to tend to increase the price of the feedstock, there is also a strong tendency to decrease the price of soybean meal for use as livestock feed, through competition from distiller's dried grains and solubles. Thus, there is a clear cut impact of ethanol production within the agricultural community in terms of crop values. A key facet of the survey of existing feedstock and by-product producers and market organizations will be to determine how this market externality might be internalized or compensated for. Another key facet of this survey

will be to determine the level of interest and potential financial capability of these organizations, (particularly producers' cooperatives), in participating directly or indirectly in fuel ethanol production. In light of the extensive interest in production at small scales, some further consolidation might allow for investment in commercial scale facilities.

The potential utility of long term purchase contracts, combined with debt or equity interests in production facilities, will be explored as methods of reducing uncertainty and risk for both ethanol producers and feedstock producers.

Financial Survey of Agriprocessors

Agriprocessing firms appear to have significant advantages in production cost and risk, including readily available feedstock procurement systems, already developed production sites, and lower risks due to capital flexibility and the ability to spread risk over diversified operations. In light of these advantages and the current trends in new production capabilities (almost all of which are associated with wet milling operations), the current and projected financial structure of agriprocessing firms is viewed as critical to the short term future of ethanol production from biomass.

The survey proposed herein has two distinct phases, a financial data collection questionnaire and industrial concerns seminars. The first phase will solicit those common corporate financial parameters which have been shown to be important to economic viability of ethanol production. Among these will be at minimum:

- ° Current distribution of operating income among product lines
- ° Relative profitability of product lines
- ° Debt/equity structure
- ° Credit history and capitalization
- ° Capital life structure
- ° Depreciation and tax considerations

These financial parameters will be analyzed to develop a baseline profile for potential agriprocessor investors in the ethanol business. This typical investor profile and significant variations in financial parameters will be used to structure the detailed (site specific) feasibility studies effort. While this approach is not specific to particular corporations, it is felt to represent a more realistic approach than a simplistic "target rate of return" type of approach.

The second phase of this task group will consist of a series of seminars for interested firms, during which commercially perceived barriers to entry, perceptions of profitability and risk, and other factors relevant to commercialization will be defined. While competitive interests may prevent full open discourse, IINR will attempt to minimize this disincentive by conducting private sessions, assuring confidentiality, and presenting the results of preliminary feasibility and siting studies during these sessions.

TASK GROUP 6, PLANT LOCATION STUDIES

Introduction

This task group is designed to address both economic and environmental concerns in developing commercial production in the State. The fundamental locational question is one of cost effectiveness, subject to constraints on timing, an overall market scenario, environmental quality, and economic risk.

The first two of these elements will be produced as outputs of the overall feasibility task group. Given national market scenarios for ethanol and agricultural products, transportation cost considerations will imply definite upper limits to Illinois ethanol production over time. These upper limits, combined with considerations of plant scale, will be used to derive an upper bound on the numbers and sizes of production sites. Some flexibility in the required number of sites will be incorporated to allow for the fact that many candidates may be infeasible for some reason.

The sites identified in the Preliminary Site Screening task group will be screened again with emphasis on market and plant scale factors. This process will involve elimination of those sites which are of insufficient size for economically viable facilities (based on the minimum viable scale) or are located in unfavorable proximity to other existing or potential sites. Once sites have been screened using this technique, probable future production will be "assigned" to sites.

The assignment of production to alternate sites will be basically a three stage analysis. First, site specific factors will be used to adjust the production function for the baseline technology. This process amounts to shifting segments of the total cost curve due to lower or higher costs characteristic of a particular site. In cases where no particular information on such site specific costs is known, the standard cost forecast for the appropriate plant scale range will be utilized.

The second step in this assignment process will be to rank technologies with regard to viability in light of siting constraints for integrated technologies. This analysis is included to reflect the expected economic advantages of these technologies vis-a-vis the baseline technology. (While this would seem to imply that only integrated technology plants would be built, site or market constraints within the agriprocessing industry may limit the development of this sort of facility.)

The third step is the actual assignment of production to specific sites in order of cost effectiveness in production and transportation. This will be based on simulations of several future conditions, and will be consistent with the production limits established at the State level. A simple feedstock supply and production/distribution accounting system will be developed based on market density factors and least cost

transportation routings. This system will make assignments of feedstock to producers and product to markets for each round in the analysis, and will "keep track" of these assignments.

The result of this three stage analysis will be a set of prescriptions for the most cost effective method to produce estimated maximum quantities of fuel ethanol for each of several future years, based on realistic assessments of site and feedstock market limitations. It is emphasized that this least cost approach does not guarantee commercial viability for production as a whole or for any particular site. It does, however, provide a method for identifying the best candidates for site specific feasibility studies in a framework which accounts for market interactions, resource limitations, transportation requirements, and the geography of candidate sites.

TASK GROUP 7, SITE SPECIFIC FEASIBILITY STUDIES

Introduction

This task group is addressed to detailed studies of commercial feasibility for each of the several best site-facility combinations identified in the Plant Location Study task group. While it is not possible to prespecify the exact number of these studies, it is anticipated that from 5 to 15 will be conducted in parallel. While these efforts will be carried out within a common analytical framework, each will be tailored to the specifics of a site, facility, and project sponsor. It is emphasized that every effort will be made to involve particular corporate sponsors for each study. The relative emphasis placed on various study elements will depend largely on the sponsor's concern. The financial responsibilities for this phase of effort will be allocated based on several factors, including the preliminary feasibility assessment made earlier in this study. Major tasks within each of these feasibility studies are discussed below.

Formulate Development Timetables

Based on regulatory and permitting requirements, a construction timeframe appropriate to the type and scale of plant, and the sponsor's investment goals and constraints, a project development timetable will be formulated. This timetable would include all major regulatory, marketing, design, and construction steps required to bring the facility to a design level of production.

Preliminary Engineering and Cost Refinement

As indicated in the plant location studies, each site will be associated with a range of potential plant scales. Although every effort will be made during preceding analyses to narrow this range, it is anticipated that as much as ± 15 percent variation in possible scale of plant may remain for some sites at the initiation of the Site Specific Feasibility Study task group. Thus, some preliminary design work will be required to specify precise scale of plant.

Once the scale of plant has been selected, a plant operating regime will be established based on site specific considerations. For baseline technology plants, normal operation and maintenance requirements will govern the choice of production schedule. Operating schedules for plants utilizing waste heat will be designed to reflect reliability and cost factors, and those plants utilizing wet milling or other integrated agriprocessing technologies will have operating schedules reflecting constraints inherent in "parent" plant operations.

Plant layouts will be developed based on site considerations and the materials handling requirements implied by planned operating regimes. After development of complete layouts and plant operating regimes at each of the sites chosen for site specific feasibility analysis, both the capital and operating cost requirements of each

proposed plant will be re-estimated in greater detail. To the extent practicable within the timing constraints of the study, these refined cost estimates will be supported by site specific cost data generated through the commercial interests sponsoring each of the studies. These cost data will include specific consideration of the construction and operating requirements associated with the use of waste heat from power plants or other sources, site specific costs for other energy sources including coal based on prevailing local prices and the possibility of long-term contracts, and previous experience of commercial interests associated with each study in bidding or constructing facilities at or near each site.

Specifications will be written based on the process flow schemes being developed. Certain minimum requirements will be established to guarantee flexibility, reliability, and plant life. The specifications will be different for various plant sizes, reflecting economies of scale with larger units or reduced process stages such as drying the distillers grain.

Major pieces of equipment such as distillation towers or fermenters will be specified in greater detail than less important pieces. This will assure that the major equipment is designed with flexibility and operability in mind. Care will also be taken to make sure that system bottlenecks do not occur in the areas of major equipment.

As the process scheme develops, layout sketches will be made of the entire plant. This will locate equipment and identify both grain unloading and product loading facilities. Items such as access for maintenance and plant expansion will also be considered. Larger area sketches will also be prepared to show items such as plant access and auxiliary equipment location.

A major portion of this project will be the support system which will provide water and steam for the process. The water equipment will be very site specific. It will depend on the type and quality of water available to the site. Wastewater purification and handling equipment will also be developed based on the individual site.

Economic and Financial Analysis

The basic analytical framework proposed for site specific financial and economic analysis is a detailed stochastically formulated cash flow and internal rate of return model. Several off-the-shelf financial modeling systems are available for the rapid construction and utilization of such a technique. Calibration of such a model to the financial and economic considerations within each site specific feasibility study will be accomplished by defining costs and revenue streams, construction timetables, capital requirements, the financial characteristics of the production incentive scenario developed earlier, and site specific risk factors. The stochastic formulation proposed for use in cash flow and internal rate of return analysis will allow for direct, quantitative treatment of uncertainties and risks involved. (Rather than specifying all cost and revenue streams as single values, it will be possible to specify them as probability distributions of several different types.) Thus operating results, cash flow, and internal rate of return for any proposed facility will also be displayed in probabilistic terms, allowing a quantitative assessment of uncertainty and risk for each feasibility study. This explicit treatment of risk is rapidly becoming the standard feasibility analysis

technique for commercial applications, and will allow much more rapid and meaningful assessment of results with consequently shortened decision-making timeframes on the part of potential industrial sponsors.

While not all uncertainties and risks can be quantified to the degree appropriate for explicit treatment in such a stochastic model, it is proposed that the degree of risk associated with major uncertainties will be quantified and treated in this fashion. Among these are changes in end-use technology, changes in tax and incentive policies, development of superior ethanol technology, development of major commercial synthetic gasoline from coal and natural gas sources, and rapid increase in real feedstock prices. Our understanding of the basic dimensions of each of these major significant risk factors is discussed below.

Major changes in end-use technology, e.g., massive conversion to transit, widespread use of electric vehicles, or other such factors, is a risk with potentially severe consequences in terms of deterioration of the primary market for fuel ethanol. It is noted, however, that this risk would be gradual and that large capital replacement requirements for such a shift would seriously impede the rapid conversion to such new technologies. The estimated timeframe for occurrence of this risk factor is from 10 to 30 years, and it is estimated that clear market warnings will be present at least 5 to 10 years prior to any major threat from this risk source, allowing a relatively orderly transfer to alternate technology or disinvestment.

Changes in ethanol production incentives pose perhaps the most serious short-term source of risk for potential ethanol producers. Within this category would be included expiration or repeal of the federal and state tax incentives which currently exist for ethanol production, or any of the loan guarantee direct loan or purchase agreement policies proposed as incentives under PL 96-126 or other Federal policies.

The consequences of full realization of this risk could be extremely severe for the ethanol market in the short-term, essentially wiping out the existing economic advantage of ethanol production instantaneously. This would be an almost certain consequence of the simultaneous or near simultaneous repeal of both the Federal and state tax exemptions for ethanol blended gasoline. An equally severe but more gradual scenario would occur with the expiration or phasing out of any or all of these tax policies. It is emphasized that as gasoline prices increase over time relative to other commodities, the potential consequences of such policy changes for ethanol producers may be much less severe. A conservative estimate of the timeframe associated with this risk (for Federal policies) is for 12 to an indefinite number of years in the future. State tax policies could be much more volatile in the short-term period, since the revenues foregone represent a higher proportion of total revenues. Very little market warning would be associated with potential changes in either Federal or state tax policies.

The development of superior ethanol production technologies, (including direct bioconversion or adsorption with elimination of distillation steps,) pose a potentially serious medium to long-term threat to producers of ethanol by

conventional means. The timeframe associated with probable commercialization of these technologies is, in our estimate, from 3 to 10 years. The consequences of this risk factor would depend of course on the degree of commercial superiority achieved in alternate technologies and on the potential for retrofitting conventional plants for advanced methods. While no precise estimate can be made of the future reduction in ethanol production costs that may occur through implementation of these alternate technologies, it is noted that any technology which achieves elimination of the distillation steps will be far more cost effective than the technology which is the subject of the current proposal.

Although it might appear that the consequences of the risk source are not direct for ethanol producers utilizing conventional technology, there could be a significant impact via the mechanism of competition for feedstock. An ethanol producer utilizing an alternate technology (with much lower production costs) could afford to bid up feedstock prices to levels where conventional technologies became uneconomic. Once again, this phenomenon would depend on the degree of commercial scale application of both conventional and alternate ethanol technologies, and on other demands for feedstocks. It is estimated that the warning period for this risk factor would range from 2 to 5 years.

The development of major commercial synthetic gasoline or methanol from coal or natural gas sources could represent a significant midterm or longterm risk to potential ethanol producers. The timeframe associated with this risk is estimated at from 10 to 30 years, and its consequences would be gradual but potentially severe deterioration of the primary

market for fuels ethanol. As with other "substitution risks" the rapidity of the occurrence of this risk will be limited somewhat by capital replacement factors in the end-use technology. At the current time, another limiting factor on the speed with which this risk factor could occur is the requirement for substantial technology development in the coal or natural gas conversion industries. On this basis it is felt that the warning period for this risk factor is from approximately 5 to 15 years.

Rapid increases in feedstock prices due to either increased agricultural or energy conversion demand could pose a serious but self-limiting risk to fuel ethanol production. The timeframe associated with this risk factor is estimated at from 0 to 30 years, based on the natural and policy induced volatility of the feedstock markets. The consequences could range from short-term shutdowns or acceptance of operating losses for short periods of time, to permanent shutdown of significant numbers of production facilities if the increased demand is from agricultural uses. (The demand for feedstock grains as a factor in ethanol production is highly elastic in comparison to demand for these grains for feed purposes.) A warning period estimated to be associated with risk factor is from 0 to 2 years.

TASK GROUP 8, SURVEY OF POTENTIAL STATE POLICY MEASURES

Introduction

In addition to the wide array of policies that influence any industrial activity at the State level, many policies directed specifically at the fuel ethanol industry could substantially improve the prospects of rapid commercial development of this technology. This task group is designed to screen existing policies in order to assess

their impact on this market, and to identify those new policies which might significantly influence the degree and timing of entrepreneurial activity. Emphasis will be on identifying a set of potential policy shifts which would require a minimum of legislative activity. Based on the results generated during the site specific feasibility task group, certain of these policy measures will be selected for discussion with project sponsors, and may be incorporated in joint development agreements.

The approaches to each of several policy measure categories are discussed below:

Taxation Policies

While the issue of possible exemption of alcohol blended fuels from the Illinois Tax on motor fuels has been considered in a legislative context, no systematic assessment of the potential impact on industry development has been made. This basic economic question will be addressed by examining the sensitivity of the production functions developed in Task Group 1 to further incentives which would be offered by partial or complete exemption. The potential economic gains in terms of payroll and other factor payments will be compared with the already well documented fiscal impacts of such a decision.

Also addressed will be considerations of tax treatment for by-products, including distillers dried grains and other joint agriprocessing products.

Corporate taxation policies also bear obvious relevance to commercialization. The impact of existing State corporate taxation policies will be characterized as a fraction of total life cycle production costs using the life cycle costing model

utilized in site specific feasibility studies. Both accelerated depreciation and tax rate adjustments will be considered.

Financing

Although not capital intensive by comparison with other energy technologies, ethanol production from biomass is subject to the same fundamental rate of return constraints which govern commercialization of any technology. With the current capital market, the demand and supply side risks in this technology require substantial pro forma rates in return. Provision of direct financing via state sources can alter this prognosis in two ways. First, State financing provides an obvious cost of capital advantage. Perhaps more important, it results in a mechanism for risk sharing. Unlike most states, Illinois has in place the basic legislation and administrative mechanisms for provision of such direct financial participation via the Energy Bond Fund program which allows direct contributions for capital purposes. The analysis of direct financing policies will focus on the features of this program and the feasibility of significant expansion in financial scope.

Loan guarantees, similar to those currently being offered under PL 96-126, can provide the risk sharing advantages of direct state financing at substantially lower public cost than direct financing. The feasibility of offering loan guarantees under the Energy Bond Fund program will be investigated within this task group.

Permitting Processes

Any new facility proposed for construction faces potentially large delays due to permitting requirements under several Federal and state laws. While this proposal does not question the soundness of these permitting requirements, the current administration of these permitting processes can result in delays which frustrate rapid commercialization of ethanol production. The State is currently actively engaged in streamlining the decision making involved in permitting processes generally. The focus of this work element will be in identifying possible permitting delays for ethanol plants, with obvious emphasis on energy input and associated air emmissions. In addition, the water withdrawal and wastewater permitting processes will be surveyed for identification of delays. The possibilities of prescreening of particular sites by permitting agencies will be investigated at an early stage, and if possible this involvement will be implemented in the site specific feasibility studies effort.

Utility Regulation and Planning Processes

As noted in the technological discussion, the economics of ethanol production are improved by utilization of waste heat at power plants or industrial facilities. At present, there is no effective mechanism for the statewide dissemination of information on potential waste heat sources. As a part of the state policies survey, a process for generating this information in a comprehensive and timely fashion will be formulated. The survey of potential sources in task group will furnish a starting point for this effort, which will also examine current utility regulatory practices.

MANAGEMENT PLAN

The plan for managing the proposed feasibility studies includes several key elements:

- Substantial IINR staff effort at the managerial, administrative, technical review, and technical performance levels.
- Involvement of two well qualified technical consultants for provision of the bulk (roughly 75 to 80 percent) of the technical analysis services required.
- The use of well defined interim products at both the consultant and the staff level to assure continuous timely review and schedule compliance.
- The utilization of a steering committee composed primarily of industrial interests, with expertise in the subject technologies.
- The utilization of corporate sponsors for site specific feasibility studies. Each of these features of the project management plan is discussed in greater detail below.

Staff Development

A full time project director will be appointed from existing IINR staff and devoted full time to the prosecution of these feasibility studies until completion. Qualifications for an individual who has been nominated to fill this post are presented in Section IV. An administrative assistant will be hired and assigned also on a full time basis to assist in financial record keeping, project monitoring, correspondence, etc.

In addition, it is proposed that three technical staff specialists will be appointed in technical review and technical performance roles. These personnel would include a mechanical engineer, an environmental engineer, and a resource economist. Each of these personnel would contribute a fraction of his or her time to the biomass

feasibility study and would have duties involving the preparation of feasibility study elements in various areas and the review of interim submissions by both technical consultants.

Technical Consultants

It is felt that the use of technical consultants can minimize managerial problems within the Institute. Such a policy will take advantage of expertise that has been developed within the consulting community, and will avoid the problem of substantial staffing for a temporary assignment within the Institute. Stanley Consultants, Inc., has agreed to serve as general technical consultant in the areas of overall feasibility, site screening, and location studies, financial capabilities and market organization, and portions of site specific feasibility studies. In addition, SCI will provide ongoing direction on overall technical management of the study. Wentworth Brothers has agreed to provide consulting engineering services to the Institute in the areas of technology survey and documentation, and preliminary engineering services as required during site specific feasibility studies.

Interim Output System

Both consultants will be required by contract to submit the results of several discreet analytical steps during the conduct of the study as formal contract deliverables. A schedule of contract deliverables is included on the following page. Use of this technique will allow the Institute to manage consultants' performance in a timely and efficient manner. All payment under both consulting contracts will be tied to Institute approval of these interim outputs.

Steering Committee

A steering committee will be structured to guide the overall emphasis and direction during the conduct of the general and site specific feasibility studies.

During the site specific feasibility studies phase of work, several parallel detailed feasibility studies will be conducted for site/facility combinations, which have emerged as economically and environmentally promising during the first phases of work. These studies, to the extent possible, will be conducted for particular corporate sponsors who have been identified through the steering committee. It is proposed that the level of involvement for corporate interests at this point should be increased to include primary responsibility for study conduct, and commitment to a definitive "go - no go" decision at the conclusion of each site specific feasibility study.

Corporate Sponsorship

The primary objective of the proposed study is to promote development of economically and environmentally sound production in Illinois. Thus, it is proposed that once the basic feasibility study, technology survey and documentation, and preliminary site screening have been accomplished, the level of corporate involvement will intensify during plant location and financial capability surveys. At this point, it is envisioned that particular industries would become involved in providing detailed data based on their experience with various locations or processes, or corporate specific financial information to be used in feasibility assessment.

Project Organization

Figure 3 indicates overall organizational links for the proposed study. Within the Institute, a project management team will be structured as indicated in Figure 4.

FIGURE 3

PROJECT ORGANIZATION

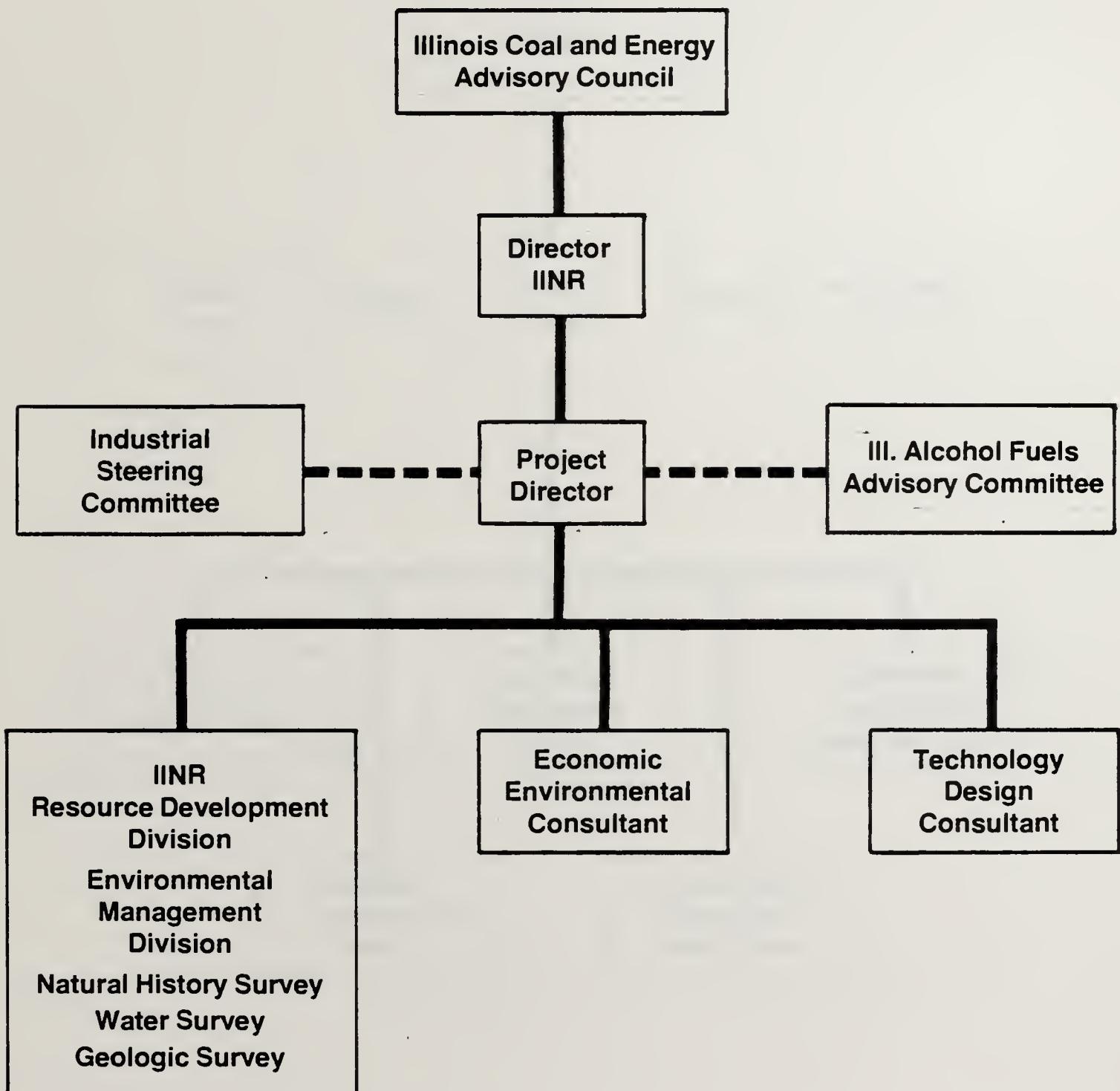
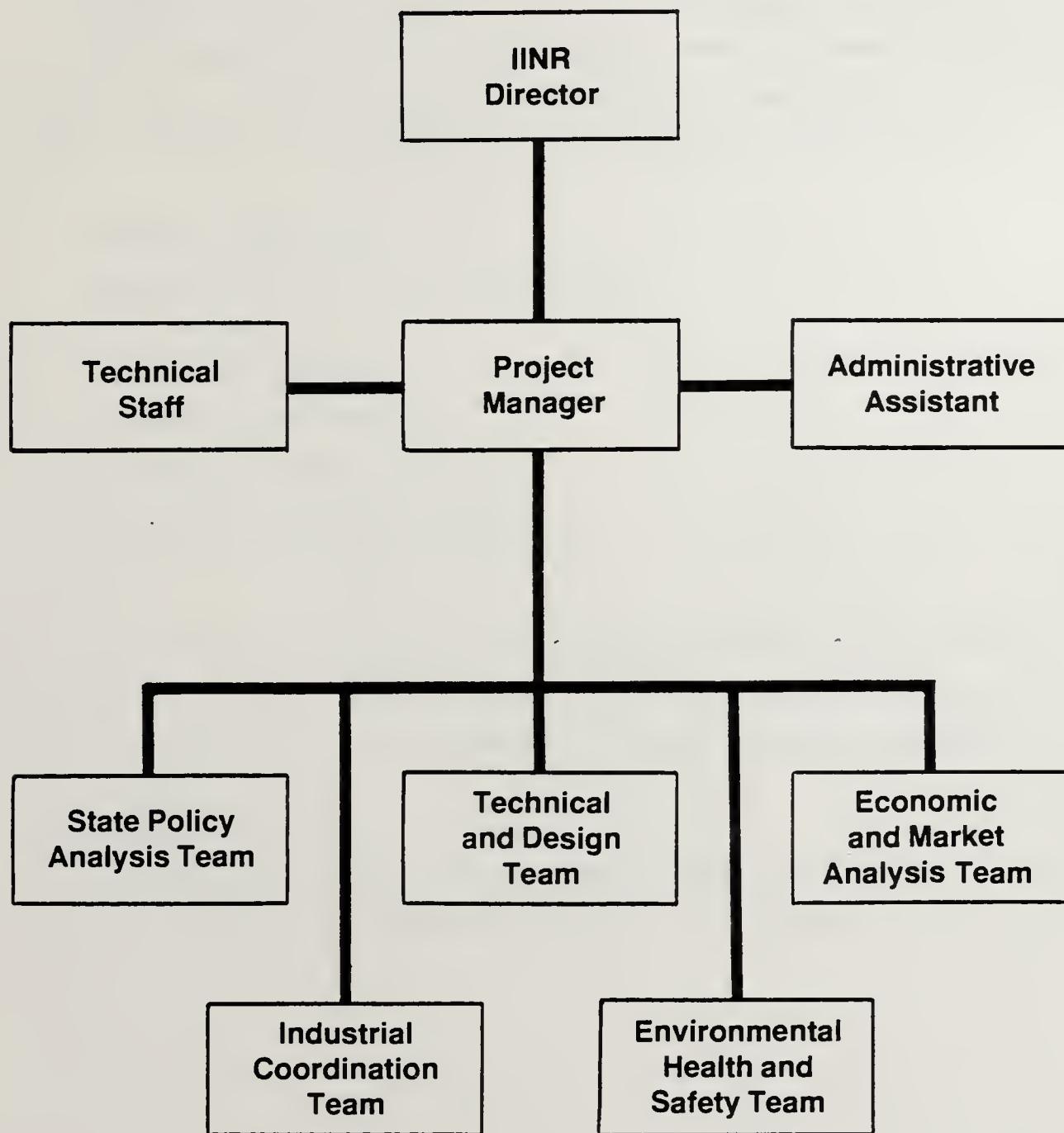


FIGURE 4

IINR PROJECT MANAGEMENT ORGANIZATION



Distribution of Effort

Proposed levels of effort, in terms of manhours, is presented on the following two tables. This manhour summary presents the detailed distribution of manhours by major discipline category and by task group. Level of effort by percentage of total manhours by task group are:

Overall Feasibility	10
Technology Survey and Documentation	16
Site Screening	7
Plant Optimization	3
Plant Location Studies	5
Financial Capability Survey	11
State Policy Factors Survey	13
Site Specific Feasibility Survey	35

An important fact in the distribution of effort is that nearly 40 percent of the effort is related to engineering and over half of the total project is in site specific studies including conceptual plant design.

Deliverables

In addition to reports for each major task group, other deliverables and major milestones are set forth on page 44.

ILLINOIS INSTITUTE OF NATURAL RESOURCES

STATEWIDE FEASIBILITY STUDY OF ETHANOL FROM BIOMASS

Manhour Estimate by Category

	TINR STAFF EFFORT				
Project Director	Mechanical Engineer	Environmental Engineer	Resource Economist	Admin. Assistant	Clerical
Overall Feasibility	360	40	80	340	80
Technology Survey and Documentation	540	260	100	260	120
Preliminary Site Screening	120	100	160	80	60
Plant Optimization Studies	100	60	—	40	20
Plant Location Studies	200	40	40	120	40
Financial Capability and Market Orientation	360	—	—	360	300
State Policy Factors Survey	520	—	180	600	300
Site Specific Feasibility	920	280	0	920	360
Totals	3,120	780	560	1,800	1,280

ILLINOIS INSTITUTE OF NATURAL RESOURCES

STATEWIDE FEASIBILITY STUDY OF ETHANOL FROM BIOMASS
SUMMARY OF MANHOUR ESTIMATES BY TASK GROUP

Manhour Estimate By Category

	CONSULTANT				Clerical/ Technical
Project Manager	Technical Manager	Principal Economist	Principal Engineer	Engineer	
Technology Survey and Documentation	20	160	20	—	400
Overall Feasibility	20	100	300	320	—
Preliminary Site Screening	20	80	60	—	480
Plant Optimization Studies	20	40	80	60	—
Plant Location Studies	20	60	120	100	160
Financial Capability and Market Organization	20	180	160	260	—
State Policy Factors Survey	40	20	280	60	80
Site Specific Feasibility	200	300	460	500	1,320
Totals	360	840	1,480	1,300	1,980
					2,160
					1,200

DELIVERABLES AND MAJOR MILESTONES

<u>Item</u>	<u>Months From Grant Award</u>
Negotiate Consultants Contracts	.5
Formalize Industrial Steering Committee	1.0
Design Financial Capabilities Survey	3.0
Submission of Review Drafts	
Technology Survey	6.0
Overall Feasibility	6.0
Site Screening	6.0
Technical Staff and Steering Committee Review	
Technology Survey	
Overall Feasibility	
Site Screening	7.0
Submission of Interim Report	
Plant Optimization Studies	8.0
Submission of Interim Report	
Plant Location	10.0
Define Financial Terms of	
Participation in Site Specific Studies	7.0
Initiate Selection of Project Sponsors	8.0
Initiate Site Specific Studies	10.0
Complete Selection of Project Sponsors	12.0
Submission of Review Draft,	
Policy Factors Survey	12.0
Complete Staff and Steering Committee	
Review of State Policy Factors	15.0
Complete Site Specific Studies	18.0

COMMERCIAL VIABILITY

Site and Site Selection Suitability

The State of Illinois represents an almost ideal collection of siting possibilities for fuels ethanol producers. Corn, which is a tested feedstock for this technology, produced in vast quantities in the state. Approximately 20 percent of current national corn crop is produced here. The state is also a major livestock producer, a factor which minimizes transportation (and possibly drying) costs for another major by-product of the proposed technology. The state includes several major metropolitan areas which are obvious demand centers for motor fuels, is centrally located with respect to major metropolitan areas in nearby states, and has extensive, well developed transportation systems for bulk commodities including rail and barge facilities.

In addition to these factors which favor the development of ethanol production from biomass using a "baseline" technology, the State includes over 100 agricultural processing firms, among which are 3 major wet milling operations. The integration of agricultural processing technology with ethanol production reduces producers' risk, and most of the current commercial ethanol for fuels production is conducted in conjunction with wet milling operations.

Another generalized factor which favors the development of fuels ethanol industry in Illinois is the presence of abundant supplies of coal for use as an energy input source. Based on a characteristic energy balance for typical fuels ethanol plant, utilization of petroleum derived fuels results in a clear net loss of energy in the form of easily transportable motor fuels for existing end use technology.

Substitution of coal as the energy input medium, however results in a clear gain in energy in the form of usable motor fuels. Thus, the abundance of coal resources in conjunction with feedstocks,

markets for by-products, and the other factors outlined above represent an almost unique combination of resources for ethanol production from biomass.

In addition to these generalized factors, which clearly favor the development of fuels ethanol production from biomass in the state, the site screening and selection methodology included in the proposed study design takes account of the most relevant site specific factors which could ensure the most economic, energy efficient, and environmentally sound application of this technology at particular sites. This site selection methodology stresses selection of sites which offer cheap or virtually free input energy, location in close conjunction with existing transportation and storage facilities for feedstocks and by-products, and adequate environmental capacity for air and water emissions associated with fuels ethanol production.

Suitability of Process to Resource Base

Corn has been shown to be superior for ethanol production to almost all other agricultural products produced in the United States. The fundamental reason for this is the high starch content in the grain and the ease at which it can be handled. An additional factor which makes corn a suitable feedstock is that protein content is fairly easily recovered with current technology. This recovery of the protein value in the feedstock is the key to commercially viable production at the current time. Based on today's prices, a typical fuels ethanol plant utilizing corn as feedstock and producing distiller's dried grains as a by-product would derive approximately 30 percent of its revenue from sales of the by-product.

- Suitability of Plant Output to Market - Numerous studies have demonstrated the technical suitability of ethanol as additive in unleaded gasoline. In addition to these

technical studies of end use technology, current consumer response suggests that the product is being well received, and that consumers consider gasohol at least a perfect substitute for unleaded gasoline, and in many cases seem to prefer the ethanol blended product. Fixed investment of substantial capital in the end use technology of automotive engines ensures that this market will remain in place for a considerable time to come. Even ultimate conversion to other end use technologies (electric cars, diesel, etc.) would require enough time for an orderly transition out of the ethanol market. In addition to the domestic market, several international markets for ethanol are developing. Failure of the domestic market would not imply complete shutdown of fuels ethanol producers in the United States.

An additional market possibility could open for use of ethanol as a major chemical feedstock, but this is a long-term possibility.

◦ Technical Readiness - As noted above, this study will consider both a 'baseline' technology utilizing shelled corn as a feedstock, and variations of this technology based on integration with various types of agriprocessing plants. This section defines the more important features of the baseline technology.

To produce anhydrous ethyl alcohol from corn the corn starch is converted to sugar with enzymes, and the sugar is fermented with yeast to produce alcohol, and the alcohol is separated and purified in a distillation process.

Alcohol and water form an azeotropic mixture having a composition of 95 percent alcohol and 5 percent water.

Alcohol for use in gasohol, however, cannot contain any water. Therefore, an azeotropic distillation must be done to produce anhydrous alcohol. This technology is well developed and proven.

Thus the commercialization of fuels ethanol production does not require the development of any new technology, only the refinement of existing processes.

A fuels ethanol process will incorporate several design modifications which are unique to this process. These modifications are possible because the product quality of the alcohol used in gasoline is different than either the quality of grain alcohol or industrial anhydrous alcohol.

Grain alcohol for pharmaceutical and food products use must be free from hydrocarbon impurities which can affect the taste, odor, and other properties required of a food grade material. These minor impurities can be tolerated in alcohol for fuels because they will not effect the combustion characteristics of the material. The water from the grain alcohol, however, must be removed. The use of an azeotrope-breaking compound is the common approach. This approach is presently used primarily to produce industrial high purity ethanol. The ethanol used for gasohol need not be high purity with respect to hydrocarbons for use in gasohol. This may allow the use of azeotrope-breaking compounds other than benzene, the current industry standard.

Plants of from one to one hundred and twenty million gallons per year will be investigated. Larger plant sizes have the advantage of economy of scale (in equipment costs). The smaller units will have reduced transportation costs and may be better able to handle

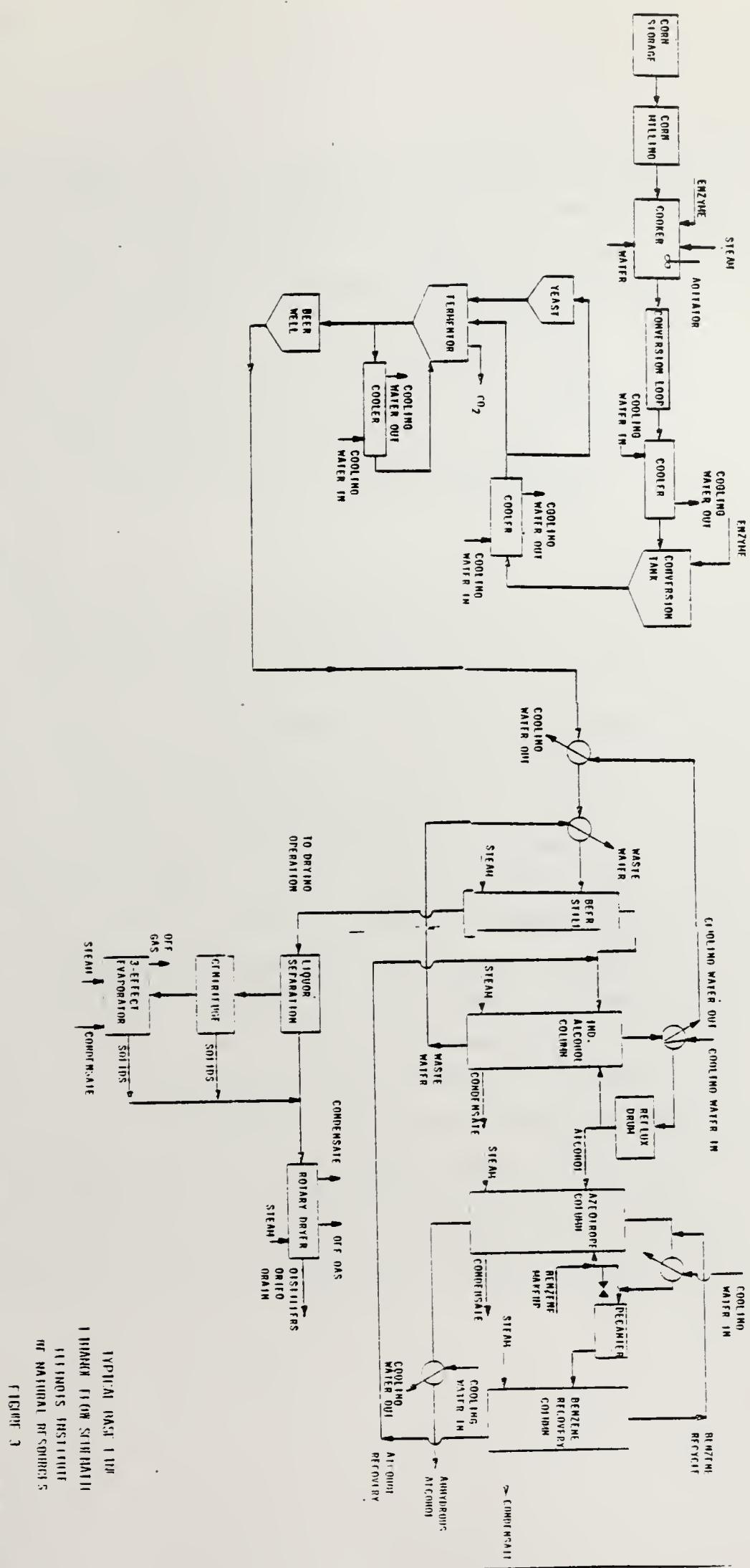
by-products. In the smaller units, the stillage may not have to be dried providing a significant energy savings.

Figure 5 is a process flow diagram for the baseline technology.

The process for converting corn into alcohol is typical of that for any grain. Corn from the storage silo is taken to a dry mill where it is ground and then transferred to the cooker, with addition of alpha amylase. The cooker breaks the starch down, after which it is cooled and transferred to a conversion tank. Here, another enzyme (typically glucoamylase) is added, which convert the starches to sugars. Further cooling is required before the sugars are put in the fermenter where, with the addition of yeast, alcohol is produced. The material is then put in a beer well for storage.

Separation of the alcohol from the by-products and waste is the next set of processes. The material from the beer well is heated and sent to the beer still where alcohol and water in about equal amounts are produced from the overhead and the stillage is removed from the bottoms. The stillage is typically sent to a drying operation where a dry cattle feed (distillers dried grains and solubles) is produced. The beer still overhead is routed to an alcohol column where 95 percent alcohol is produced in the overhead and wastewater is removed from the bottoms.

Further distillation of the overhead will not remove the water because of the azeotrope formed at this concentration. The alcohol column overhead is therefore fed to an azeotrope column where, with the addition of benzene or some other azeotrope-breaker, further separation occurs. The azeotrope-breaking compound and water go overhead in the azeotrope column, with anhydrous alcohol yielded at the bottom. The overhead reflux drum of the azeotrope column will



develop a two-phase liquid. The top layer is primarily the breaking compound, which is returned to the column as reflux. The bottom layer is alcohol and water. This material is taken to a recovery column where the breaking compound is stripped and recycled to the azeotrope column. The alcohol water mixture from the bottom of the recovery column is recycled to the feed of the alcohol column.

The stillage drying system typically consists of a liquid separator, centrifuge, 3-effect evaporator, and a rotary dryer. These steps are necessary to produce a dry feed material which can be stored.

Process Alternatives

- The use of gasoline or some other material in place of benzene as an azeotrope-breaker. This would result in lower costs for make-up material and will eliminate the problems of dealing with benzene which is listed as a toxic substance.
- Elimination of the stillage drying processes at smaller facilities. The wet stillage would be sold directly to feedlots without storage which could cause spoilage.
- Availability of Resources - It is noted by most of the critics of the current 'gasohol' programs, a production of ethanol from agricultural biomass is a severely resource-limited technology in the long run. Reduction of 10 percent of the nation's fuel needs in the form of gasohol to be substituted for unleaded gasoline would require the diversion of about one-half of the nation's corn crop to feedstock use. Thus, it is clear that the long run application of this technology is in no way comparable in terms of quantitative national significance to the application of other synthetic fuels technologies (including particularly coal

conversion). On the other hand, commercial scale production of fuel ethanol is feasible and is occurring. As suggested in the abstract and in more detail in the technical approach section, fuels ethanol from agricultural biomass will be a self-limiting phenomenon. The higher the level of production, the higher feedstock price (and the lower by-product prices) will be forced. The national scope of both feedstock and by-product markets indicate that national equilibrium will set prices for feedstock product and by-product, which will determine the individual viability of any proposed facility. Thus, it is a key facet of this proposal to ensure that the site specific feasibility studies conducted in the latter stages are done within the framework of a realistic and systematically derived quantitative set of price assumptions for these national markets.

Production Schedule

A feasibility study grant award during June would allow for final design to begin in December of 1981. Allowing one year for design, site acquisition, and financing would allow commencement of plant construction in January of 1983.

For a plant in the 2-5 MGY range, construction would require about 12-18 months and start-up testing would be minimal, allowing commercial scale production in 1984.

A plant in the 20-50 MGY range would require about 18 months for construction and 6 months for complete shakedown. This would allow for commercial production early in 1985.

Ethanol facilities in conjunction with existing wet milling plants could be constructed in less time since certain components are eliminated and some site preparation steps would not be required.

Ethanol plants designed to utilize waste heat from power plants or other boilers will typically call for more time in both design and construction phases, since steam transport and condensate return must be integrated with both boiler and process heat considerations.

Process Flexibility

The baseline process flexibility is excellent. Alternative starch or sugar feedstocks can be substituted with minimal problems. Addition of front-end components for cellulosic conversion extend the process to almost any biomass feedstock, making its potential applicability almost universal.

Flexibility of integrated technology is of course limited to locations of existing and future agriprocessing plants. This is not a severe limitation in view of the wide geographic distribution of such plants.

Economic Competitiveness of Plant Output

Since plant scale, siting considerations, integration of plants with agriprocessing and waste heat sources will all be established on cost criteria, plants chosen for final design and construction under this proposal will have the best possible cost competitiveness vis a vis other conventional processes consistent with sound environmental and safety practices. A comparative study of ethanol facilities using alternative feedstocks (Mitre, 1978) showed corn to be very competitive.

The only problem from this perspective is from new technologies which could eliminate distillation or utilize cheaper feedstocks effectively. Widespread application of such technology could destroy the economic competitiveness of the subject technology. As noted in the discussion of risks, this is a mid- to long-term scenario.

ENVIRONMENTAL, SAFETY, HEALTH & SOCIOECONOMIC FACTORS

Probable Issues and Proposed Approaches

The technology for the production and use of ethanol from biomass is a relatively clean one, particularly in comparison to other alternate fuels production processes. There are, however, some serious environmental considerations inherent in the development of a major fuels ethanol industry. Those topics which are proposed for study by IINR are discussed below under the major groups of site specific and general market induced effects.

Site Specific Issues

The primary site specific considerations for commercial scale ethanol production will arise from possible air emissions generated in creating process heat, liquid waste disposal and treatment, control of dust for health and safety reasons, proper handling of benzene or other denaturant compounds, and storage of the finished product.

In general terms, the level of complexity of an ethanol from biomass facility is low. Even though these potential environmental, safety, and health considerations represent a low level of risk, it is important that their consideration be made explicit in the feasibility and siting process. The methods for addressing each of the site specific factors is set forth below.

Air Emissions

Since improvement of the liquid fuels availability level via fuels ethanol production requires that input heat does not come from petroleum fuels, the two practical alternatives for Illinois are coal or surplus heat. During the technology survey and documentation, specifications for coal combustion technology will have been developed for each benchmark scale of plant. These specifications will be in the form of input and output parameters associated with the appropriate scales of coal combustion. Input parameters will include

relevant chemical characteristics of coal, and outputs will include BTU values and all chemical parameters of environmental concern. The preliminary analyses of each site specific feasibility study will include a comparison of the potential air emissions at a site with the ambient air quality and NSPS Standards. This preliminary analysis will define, within a range of options, what control strategies will be appropriate for each site. Preliminary engineering cost analysis of control strategies, consideration of size reduction of production plant, and (where required) modeling of local air quality and or detailed characterization of local coal will be undertaken to select an environmentally sound method for coal utilization at each site. During the development of such methods, air quality control cost estimates will be refined for each site.

For those facilities that could utilize surplus heat from industrial or utility boilers the environmental consequences of air emissions will be evaluated only on a marginal impact basis, e.g., if construction and operation of a proposed alcohol plant would not require additional or intensified emissions, then "feasibility" analysis will be limited to assuring existing and future compliance at the energy facility. In cases where air quality problems appear to be severe, sites may be dropped from further consideration with consent of project sponsors.

Mining Impacts

It is proposed that element of study will include very little, if any, original analysis under the aegis of the biomass study. This approach is premised on the facts that:

- ° Energy use for process energy, even in the scenario of a major ethanol industry, would represent a very small fraction of existing coal production in Illinois.
- ° The impacts of existing mining activities and proposed new activities for coal conversion are being documented extensively during other studies, including the proposed Texaco process siting study, the energyplex studies, ongoing efforts of the coal survey, and numerous site specific studies.

The only instance in which impact of mining activities would be studied will be in situations where the quality and availability of coal made a "mine mouth" ethanol plant appear economic, and involved new site specific mining activity.

Water Quality Impacts

Ethanol production requires approximately 25 gallons of water per gallon of product. With proper design, this input can be recycled so that only minor quantities (spill, etc.) of wastewater is generated. This wastewater will vary somewhat in BOD and solids content depending upon the particulars of plant design for recycling. In general, however, very high BOD levels typical of brewery wastes could be present.

The technology survey and documentation process will furnish a detailed characterization of the baseline waste treatment process for meeting effluent requirements under BATEA. These features of each project will be refined during the initial stages of each site specific study to reflect both input water quality and quantity and special assimilation capacity characteristics present at each site.

As with air quality control equipment, liquid waste handling and treatment facilities will be optimized to take advantage of site specific factors. This will include consideration of integrated industrial domestic waste treatment systems, production of methane gas for process heat use, and potential for land application of treatment sludge. This preliminary engineering will ensure environmentally sound wastewater management at each site.

Denaturant Handling

The typical practice of utilizing benzine as a denaturant in the final stages of anhydrous ethanol production implies some health risk for workers. The technology survey and documentation task group will investigate the economics of improved benzine handling techniques and of alternate denaturants. Preliminary design at each site will include considerations for safe utilization of any denaturing compound proposed.

Other Site Specific Environmental Factors

Among other environmental and health factors which would operate at the site level are exposure to dust created in grinding feedstocks, potential for dust explosions, and noise levels. While these are serious considerations in the final design process, all are well within the scope of normal engineering practice for agricultural processing facilities. It is not anticipated that any special treatment of these factors will be required.

Market Induced Environmental & Socioeconomic Concerns

The most serious class of (broadly defined) environmental impacts of major commercial development in this industry are those likely to be induced by demand and supply shifts in both input and output markets. Among inputs, concerns include price effects in feedstock and selected capital markets. Output price effects in the distiller's dried grain and solubles market have been documented by several sources.

Although the overall feasibility task group will project probable price effects in both feedstock and by-product markets at the national and state levels, transportation economics dictate that these impacts will be felt most severely in the immediate vicinity of major commercial facilities. In particular, the market for soybean meal is likely to be impacted in cases where production of distillers dried grains at ethanol plants would furnish cost effective substitution possibilities on a fairly localized level.

This potential impact will be treated separately for each site specific feasibility study. Based on the preliminary facility size and technology, potential quantities of high protein feedstuffs will be known for each site. The site specific feasibility studies will determine existing and probable future demand levels within the market area for each proposed plant based on livestock production trends, and will quantify the probable impact on soybean production and processing based on the geographic extent of existing and perceived markets. This analysis will include contacts and interviews with dealers in the vicinity of each proposed facility, and will furnish data for both the assessment of impact on existing markets and hard estimates of the quantities of DDG that can realistically be absorbed at economic prices in local markets for livestock feed. This latter information will be used to refine financial analysis at the site specific level.

Among the most widely noted market induced impacts of fuels ethanol production from feed grain is the requirement from increased grain production and its consequent economic and land use effect. Like effects in DDG markets, these are apt to be most pronounced in the vicinity of major facilities.

This set of issues will be investigated using site specific data on crop production histories and soil suitability. The analysis will involve estimating land use impacts in terms of increased acreage devoted to corn production within the feedstock market area for each proposed facility. This study will reflect the results of marketing surveys conducted with grain producers cooperatives, and, in particular, the realistic limits to the proportion of feed grain that can be diverted to fuels production given agricultural marketing practices. (1)

- (1) Existing feasibility studies assume a wide range of feedstock market densities (and consequently producer's costs) the incentives of ethanol producers and farmers vary greatly over feedstock supply issues. The producer desires assured quantities at stable (or at least predictable prices, while the farmer traditionally reacts to both supply and demand side influences with dramatic changes in production).

PROPOSER'S CAPABILITY FACTORS

Organization

Illinois Institute of Natural Resources, as grantee, will assume primary management responsibility for the overall conduct of the proposed study. In addition, technical work will be conducted by Stanley Consultants, Inc., in the areas of overall feasibility, siting studies, and environmental and financial analysis. Wentworth Brothers will conduct studies in the technology survey and site-specific preliminary engineering areas. The remainder of this section sets forth the qualifications and capabilities of each of these key participants.

Illinois Institute of Natural Resources Qualifications

Illinois Institute of Natural Resources is Illinois' state energy agency and deals on a daily basis with the complex scientific, economic, and environmental issues that characterize today's energy arena. The Institute, unlike most state agencies, has been charged with and is now executing direct financial assistance in commercializing new energy technology.

The Institute's Resource Development Division's mission is to promote the use of energy resources native to Illinois and encourage the development and adoption of untapped energy resources and new production utilization technologies. The Division is comprised of three sections--Solar, Energy Bond Fund, and Energizing Technology--all of which contain programs designed to promote the development of alternative energy in Illinois. The Resource Development Division has the necessary technical and management staff to support a project of this nature, as well as experience in policy formulation and planning. Necessary information

and input into the development of criteria essential to the determination of specific sites for ethanol facilities will be provided by state regulatory agencies including the Illinois Environmental Protection Agency.

The state of Illinois has significant experience in the planning and coordination of large coal and energy development projects. Beginning in 1974 with the passage of the Coal and Alternative Energy Bond Act, Illinois has been in the forefront of the national effort to develop an alternative fuels industry. The Bond Act authorized \$70 million to be used to further the effort.

The Biomass Energy Program has initiated a number of program activities since its inception in 1977, to encourage the development of biomass-derived ethanol production and utilization as alternative energy use and fossil fuel conservation measures. The program has focused on providing technical assistance, education and informational materials, resources and technology assessment, preliminary economic analysis, and specific research and demonstration projects in biomass energy development and conversion. Alcohol fuels activities within this program area have included providing economic, technical, marketing, and financial assistance information to investor groups and industry interested in investigating the market potential for new ethanol facilities.

A number of research projects and studies have been funded by the state through the Environmental Management Division of the Institute that are related to various aspects of biomass-derived ethanol. These include:

"Production and Utilization of Energy and Chemicals

from Biomass in Illinois - A Preliminary Analysis."

Awarded to Argonne National Laboratory (DOE). The

proposed study will provide a preliminary analysis of the potential economic and environmental consequences associated with biomass-derived energy, chemical, or material use in Illinois. It will focus on the biomass of major crop plants and of canning and food processing wastes. Three options of biomass conversion to energy and fuels will be examined, i.e., direct combustion, liquid fuels production, and gasification. Several systems for the production of biomass-derived chemical or chemicals or materials will be investigated.

Proposal for the Study of Waste Heat Utilization in Illinois.

The proposed study is to investigate the potential of waste heat utilization in Illinois for agricultural purposes, including ethanol production (scheduled for fiscal year 1981).

Identify High Yield Base Materials for Commercial Biomass

Conversion Systems. The Natural History Survey has the scientific and research capabilities to conduct this study on identification and development of high yielding biomass plant species for various bi-conversion processes. An analysis will be conducted of economically viable species and compared to compatible and available land resources in the states (scheduled for fiscal year 1981).

PROJECT TEAM SUMMARY

Illinois Institute of Natural Resources

Timothy Warren Project Director
Nicholas P. Hall

Stanley Consultants, Inc.

John H. Beasley	Project Manager
Duane T. Kexel	Study Manager
Norman B. Smith	Principal Engineer
William A. Liegois	Principal Engineer
Kenneth C. Leimkuehler	Principal Engineer
Thomas W. Wood	Principal Economist
John Sayles	Environmental Consultant
Tim J. Weyenburg	Environmental Scientist

Wentworth Brothers

Ted Wentworth President

TIME COMMITMENTS FOR KEY PERSONNEL

STANLEY CONSULTANTS, INC./WENTWORTH BROTHERS

EXPERIENCE AND CAPABILITIES

Introduction

Stanley Consultants has broad experience with projects and project activities having characteristics similar to those of the proposed Illinois project. Key areas of experience include:

- Synthetic Fuel Facility Planning and Design
- Plant Siting and Design
- Feed and Grain Process Industry Design
- Environmental Analysis
- Economic Analysis
- Industrial and Utility Process Design and Analysis

In addition to its experience in the planning and design of projects similar to that being analyzed in Illinois, Stanley Consultants also has a wide range of experience in all aspects of the related areas of water resources, environmental control, and transportation. The broad experience of Stanley Consultants will be augmented by the strong technical experience of Wentworth Brothers of Cincinnati, Ohio. Members of the firm are holders of numerous patents in related areas, and the firm has both historic and current involvement in a very wide range of methanol and ethanol production projects involving a variety of sources. Examples of relevant projects are included in the sections immediately following this introduction.

Project personnel selected to support the Illinois Institute of Natural Resources on this project will be drawn from personnel with experience on similar project activities in the past. The consultant team will be led by a project manager with responsibility for the

total contractual performance of the team. A study manager will be responsible for the day-to-day technical activities of the team and will be responsible for coordinating the varied inputs required for study execution. Serving as study manager will be Mr. Duane Kexel, a principal economist with Stanley Consultants who has recent experience with biomass projects in Illinois and broad historical experience with a variety of economic, environmental, and siting projects throughout the world. Lead personnel will include a senior process engineer, a senior chemical engineer, a senior environmental scientist, a senior economist, and a senior environmental engineer. A variety of support staff will be available. Mr. Ted Wentworth, President of Wentworth Brothers, will provide direct input to the team as a consultant and will make available other Wentworth Brothers' personnel as required to provide technical support to the total effort. Resumes of all of the lead team members are provided later in this section along with a Project Team Summary.



STANLEY CONSULTANTS, INC.
QUALIFICATIONS AND PROJECT EXPERIENCE

- History and Organization
- Expertise and Capabilities
- Industrial Process
- Feed and Grain Processing Industries
- Environmental Analysis and Planning
- Water Resources
- Air Quality Control Projects
- Typical Power Projects
- Planning and Area Related

HISTORY AND ORGANIZATION

Stanley Consultants was established in Muscatine, Iowa, in 1913 when Central States Engineering Company began practicing in the areas of hydraulics and drainage.

In 1932 the company expanded its scope of services, and the name was changed to Young and Stanley, Inc. The name was changed to Stanley Engineering Company in 1939.

In 1966 the name was changed to **Stanley Consultants, Inc.**, to more appropriately reflect the multidisciplinary services offered in all areas of engineering, architecture, environmental sciences, planning, and management on an international basis.

As our scope of professional services expanded over the years, domestic and overseas office locations were established to serve a growing list of clients in more than 42 states and 40 foreign countries, representing more than 7,700 separate and diverse engagements.

At the present time, we provide services to our clients through four operating divisions and two support services divisions.

- **Central Division** serves industrial clients and local, state, and federal government agency clients.
- **International Division** provides services to all clients outside the United States.
- **Power Division** serves investor-owned, municipal, rural electric cooperative, and other utility clients.
- **Southeastern Division**, with headquarters in Atlanta, Georgia, provides services to industrial and governmental agency clients in the southeastern United States.
- **Corporate Development and Services Division** provides technical, management development, marketing information, and other support staff services on a company-wide basis.
- **Finance and Administration Division** provides company-wide fiscal and office services support.

STANLEY CONSULTANTS



INTERNATIONAL CONSULTANTS IN ENGINEERING, ARCHITECTURE, PLANNING, AND MANAGEMENT

We have provided professional consulting services outside the United States for more than 20 years. The establishment of offices overseas reflects the firm's commitment to long-term development of the countries in which they are located.

Stanley Consultants, Ltd., (Liberia) was established in 1958 as a wholly owned subsidiary, maintaining permanent offices in Monrovia, Liberia. An office providing design services to clients in Southeast Asia was established in Kuala Lumpur, Malaysia, in 1974. Our current list of domestic and international offices also includes: Chicago, Illinois; Cleveland, Ohio; Indianapolis, Indiana; Washington, D.C.; and Quezon City (Manila), Philippines.

EXPERTISE AND CAPABILITIES

As a professional consulting services firm, Stanley Consultants is dedicated to the management of technical efforts which best represent the interests of our clients. Our professional and technical staff members participate in management and communication courses, seminars sponsored by the American Management Association, and other educational activities to improve communication, interpersonal relationships, and the overall management of professional and technical efforts for clients.

Close attention is paid to thorough and effective communication between our project managers and the project managers of our clients and/or their representatives. The emphasis that we place on these matters has repeatedly demonstrated its effectiveness in successful relationships with our clients. We believe such relationships are essential to providing quality consulting services.

Stanley Consultants has extensive experience in performing engineering studies and designs for business/industrial clients and local, state, and federal government agency clients.

Specific areas of experience and capability include:

Engineering Studies — A large part of our practice deals with the performance of engineering studies and preparation of engineering reports. We pay particular attention to the preparation of studies and reports, recognizing that such work requires specialized expertise somewhat different from that required for detail design work.

Cost Estimates — Our cost control specialists have developed a high degree of skill in estimating diverse construction costs. For example, over a period of nine years, cumulative dollar value of low bids was 5.6 percent under cumulative value of cost estimates prepared, with the largest variation of cumulative low bids in one year at approximately 10 percent below cumulative dollar value of estimates prepared.

Plans and Specifications — In the preparation of plans and specifications, standard procedures for quality control have been developed, and sophisticated procedures (such as automated specifications) are routinely used.

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STANLEY CONSULTANTS

INTERNATIONAL CONSULTANTS IN ENGINEERING, ARCHITECTURE, PLANNING, AND MANAGEMENT



Field Consultation During Construction — On a majority of design projects, we also provide engineering services during construction. In most cases, resident services are also provided. Consultation by lead design personnel during construction is a normal practice provided on most design projects.

Construction Management Services — From conception through completion, our firm offers a broad range of professional expertise in the area of construction management. On numerous projects, varying in size from small to extremely large and complex, our firm has provided assistance to client in-house staff and/or assumed total project management during the construction phase. By providing complete consultation during the design phase we can assure the correct coordination of administration, financial and cost control elements, bidding and contracting for supplies and subcontractors, expediting, site management coordination, start-up and testing, and other basic services associated with construction management as part of a total integrated project management system.

Final Revised Drawings — The preparation of final revised drawings is also carried out on the majority of our design projects. These drawings are prepared from field-marked drawings developed either by our resident engineer or by other personnel representing the client.

Value Engineering — It has long been our practice to carry out economic tradeoff studies on alternative details of design during the design process. In recent years, the technique of functional analysis by team effort known as Value Engineering has been developed to further refine the economic studies performed during design. We participate in a continuing education program in value engineering for selected individuals who, separate from the designers, can perform this additional analysis.

Quality Control — During the 65 years we have offered diversified multi-disciplinary professional consulting services, it has been our practice to pay close attention to the management of technical effort and quality control. Our matrix management system is sufficiently flexible to adapt to each client's requirements and to promote the production of quality designs. Careful attention is given to correctness of design; soundness of assumptions; and quality of studies, plans, and specifications.

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Familiarity with Contracting Procedures — Stanley Consultants has negotiated numerous contracts with Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA), U. S. Army Corps of Engineers, Rural Electrification Administration (REA), and other governmental agencies in recent years. We are extensively acquainted with the processes of proposals, negotiations, contracting, and working relationships with these agencies.

Our proposals have undergone Defense Contract Audit Agency (DCAA) audits and our standard accounting procedures have been extensively reviewed by REA, DOE, DCAA, and other DOD agency auditors. Familiarity with these audit agencies, coupled with our accounting system and basic cost information, has allowed us to carry out all required audit functions expeditiously.

Continuing Professional Development — We have a long-established policy of promoting continuing professional development of our members through cost sharing for individual member's education programs; the presentation, at frequent intervals in the home office, of technical seminars covering many fields of interest; the encouragement of members to participate in professional conferences, symposiums, and seminars; the support of and participation in research and development programs; and promoting individual member leadership and support in professional societies and association activities.

INDUSTRIAL PROCESS

The following is a partial experience listing of industrial process projects performed by Stanley Consultants. These jobs were selected as they relate to the proposed alcohol project.

Clinton Corn Processing; Clinton, Iowa

Design of a complete ethyl alcohol plant for Standard Brands. This consisted of all equipment including distillation, fermentation, and raw material preparation. The plant utilized certain off-products from the wet corn milling to produce ethyl alcohol or neutral grain spirits.

Illinois Institute of Natural Resources; Springfield, Illinois

Preliminary screening and selection of projects relating to reusable energy resources for funding by the state of Illinois. Stanley Consultants reviewed over 100 submittals by citizens of Illinois for money appropriated by the legislature. Proposals included facilities/equipment for production of ethyl alcohol for "gasohol." Stanley Consultants is presently conducting final audit and interview process with candidates.

Client Confidential

Economic feasibility for new process to produce a type of alcohol (not ethanol) for use as a motor fuel as in "gasohol." Process is proprietary in nature, having been invented and tested in Europe. Study included construction of scale model of prototype plant, cost evaluation, equipment sizing, and writing of a final report. Process included primary distillation and an azeotropic distillation to obtain an anhydrous product.

Client Confidential

Technical, economic, and environmental feasibility study for the construction of an ethyl alcohol plant for use in "gasohol." Study included site-specific parameters, process development, raw material availability, by-product disposal, major equipment selection (such as distillation columns), and costs.

Client is not presently in the starch business.

Clinton Corn Processing Company; Clinton, Iowa

Design of process and facilities to dewater, convey, dry, condition, and ship dextrose (corn sugar). Project required modification of building framing previously constructed but not completed. The building was planned for future expansion by utilizing plastic panel walls. The walls required explosion blow-out design. All equipment was specified, evaluated, and installed on the project. Equipment consisted of crystallizer discharge headers, basket centrifuges, conveyors, dryers, conditioners (coolers), screens, air conveying system, bins, baghouses, and bagging station.

The Hubinger Company; Keokuk, Iowa

Design of facilities to dry modified corn products. The scope of services included specifying all equipment and design of drying facilities retrofitted into existing plant area. Included was a building to house equipment. The building required blow-out walls for safety. A special design feature included the ability to clean up the system readily for change of product line. Equipment consisted of two vertical flash dryers, dewatering batch centrifuges, raw material pipelines, dust collectors, conveyor systems, utilities, and auxiliary systems.

Chemplex Company; Clinton, Iowa

Design of distillation tower for recovery of spent vinyl acetate solution. The column was designed to provide separation for VA reuse. Project included specifications; review of proposals; purchasing; and expediting of all mechanical equipment including distillation column, pumps, tanks, condensers, piping, valves, and all instrumentation. Tie into the existing processing facility was coordinated with operations and the latest safety requirements. Project further included other construction management services such as resident services and contract supervision.

In addition to the projects listed, Stanley Consultants has over 40 years' experience in facilities relating to the infrastructure of the alcohol project. These projects fall in the categories as follows:

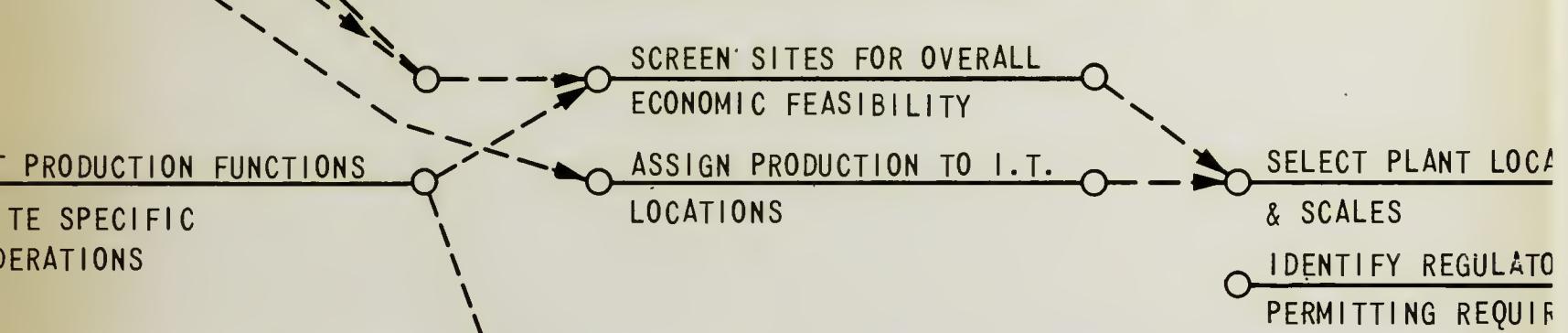
1. Utilities/Distribution and Generation
 - Electrical
 - Steam
 - Natural Gas
 - Water Supply
 - Air
2. Buildings
3. Wastewater Facilities
4. Air Pollution Abatement
 - Flue gas desulfurization
 - Baghouses
 - Electrostatic precipitators
 - Mechanical collectors
5. Tank Farms

6. Transportation Facilities

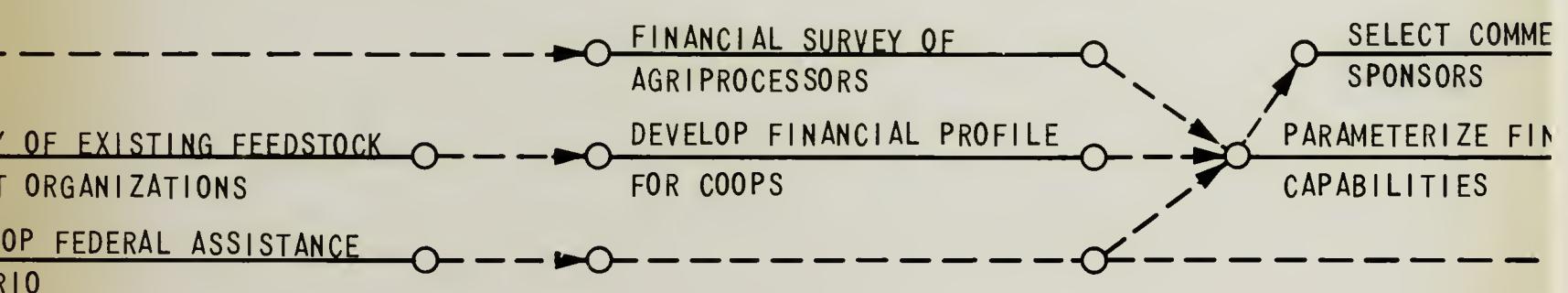
- Roads
- Railroads
- River Terminals

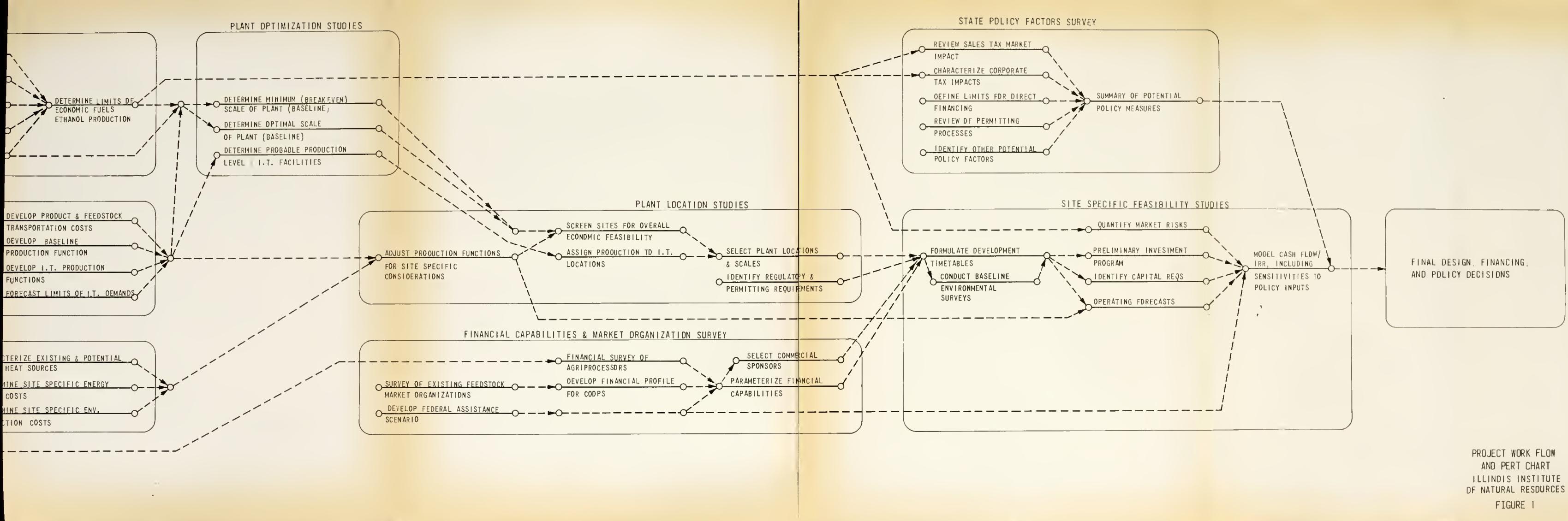
7. Permits

PLANT LOCATION STUDIES



FINANCIAL CAPABILITIES & MARKET ORGANIZATION SURVEY





FEED AND GRAIN PROCESSING INDUSTRIES

"PARTIAL EXPERIENCE SUMMARY"

In recent years, Stanley Consultants has served many firms in the grain processing industries. Representative clients are listed below.

The American Distilling Company
American Maize-Products Co.
Corn Products Division of CPC, Inc.
Clinton Corn Processing Company, Division of Standards Brands Incorporated
Grain Processing Corp.
Hiram Walker-Gooderham & Worts Ltd.
The Hubinger Company
Illinois Cereal Mills
National Starch & Chemical Corp.
Quaker Oats Co.
Sethness Products Co.
Standard Brands Incorporated

Stanley Consultants has provided the industry with study and design services in the following typical areas:

UTILITY SYSTEMS	Steam Supply Studies Electric Distribution Studies Central Steam Plants (coal-, oil-, gas-, and waste-fired) Steam Turbine Electric Generation Units Boiler Feed Water Treatment Potable Water Treatment
WASTEWATER TREATMENT	Feasibility Studies and Engineer's Reports Field Sampling Activities Waste Segregation and Inventory Studies Pilot Plant Design and Operation Treatment System Design Permit Applications
AIR POLLUTION ABATEMENT	Feasibility Studies on SO ₂ Emission Control Dust Collector System Design Electrostatic Precipitator System Design
PROCESS ENGINEERING	Wet Milling Sugar Refining Alcohol Production Starch Blending Flash Drying Caramel Syrup Production Yeast Refrigeration
MATERIALS HANDLING	Hopper and Boxcar Unload, Weigh, and Cleaning Feed Storage Feed Conveying Feed Bagging Feed Bulk Loading
BUILDING SYSTEMS	Research Laboratory Design Office Design Structural Analysis and Design

PROCESS CONTROL AND INSTRUMENTATION

Stanley Consultants has a wide and varied background in the design of analog and discrete instrumentation and control systems related to grain processing plants, chemical processing plants, wastewater treatment facilities, air pollution abatement systems, and steam and electric generation plants. Design work has encompassed pressure, flow, temperature, level, analytical, vibration measurement, and control applications as supplied to corn syrup production, distilling, petrochemical recovery, feed grain handling, industrial wastewater treatment plants, and steam generation. Design has included complex analog and discrete instrumentation and control systems. Analog instrumentation and control systems designs have utilized conventional pneumatic and electronic hardware, as well as the more sophisticated microprocessor-based control systems, such as the Honeywell TDC-2000 system. Discrete control systems design work has used both traditional relay, timer, drum programmer, type, equipment, and state-of-the-art programmable controllers such as Modicon and Texas Instruments.

The level of design work has varied from feasibility studies to detailed design, procurement, construction management, and start-up.

Representative projects include:

STEAM GENERATION

- Detailed design combustion, feedwater, and burner management instrumentation and control systems for six 175,000 lbs/hr pulverized coal, liquid residue, hydrogen, and fuel oil-fired boilers. The analog control systems were designed around a microprocessor-based (Honeywell TDC-2000) control system. The burner management (discrete) systems utilized a

programmable controller. Design work also included instrumentation and controls for ash handling, coal handling, coal car thawing, and flue gas monitoring systems. Software development for the analog and discrete instrumentation and control systems was completed by Stanley Consultants.

- Plans and specifications for combustion controls and related flow metering, instrumentation systems for three 50,000 lbs/hr gas- or oil-fired boilers and three 1 MW single automatic-extraction, condensing steam turbine generators. Design utilized sophisticated microprocessor-based data transmission and logging system.
- Detailed design of combustion and burner management instrumentation and control systems for three pulverized coal, fuel oil, and ethane gas-fired boilers rated at 250,000-lbs/hr. The combustion controls (analog) were designed using conventional pneumatic hardware. The burner management (discrete) control systems utilized programmable controllers. All discrete software were designed by Stanley Consultants.

FEED AND GRAIN PROCESSING

- Design of instrumentation and control systems for flash drying of corn starch. Analog instrumentation included temperature controls and flow metering. Conventional discrete logic systems were also designed for this project by Stanley Consultants.
- Detailed plans and specifications for corn sugar refining plant. Scope of work included discrete logic and annunciator systems for corn syrup production, crystallization, and

centrifugation of crystalline dextrose, conveying of dextrose crystals, drying and conditioning of crystals, and storage and bagging facilities.

- Design of instrumentation and control systems for feed handling. Scope of work included design of bin weighing systems and conventional discrete logic systems for drying-weighting, air conveying, and loading systems.
- Design of instrumentation control systems for caramel syrup food coloring and flavoring process using analog instrumentation, which included pressure and temperature recording and control.
- Design of instrumentation and control systems for completed alcohol plant. Scope of work included analog instrumentation for distillation, fermentation, and raw material preparation. Conventional pneumatic hardware was utilized.

PETROCHEMICAL PROCESSING

- The detailed design of instrumentation and control systems for a petrochemical recovery plant. The instrumentation and control systems for the distillation column, reboiler, bottoms, feed, product, and reflux were included in this project. Miniature electronic hardware and digital temperature instrumentation were used on this project.
- Conceptual design of instrumentation and control systems for spray dryer systems. Applications included a flue gas desulfurization process and a chemical product drying process.

WASTEWATER TREATMENT

- Detailed design of a 1 mgd secondary wastewater treatment process for a chemical plant. Major design areas included instrumentation and control systems for pH neutralization, flow equalization, and various discrete logic systems. Miniature electronic hardware was utilized for this project.
- Detailed design of instrumentation and control systems for a chemical plant's primary and secondary wastewater treatment plant. This project included flow, level, pH, temperature instrumentation, and control systems applications.

AIR POLLUTION ABATEMENT

- Detailed design of instrumentation and control systems for several large industrial air pollution abatement systems (baghouses). The control systems designed have been for pulse air, reverse air, and shaker-type baghouses. Analog instrumentation and control systems for pressure, temperature, and vibration have been applied to this project. The discrete control systems have been both the conventional relay, timer, drum programmer type, and programmable controller-based.

POTABLE WATER SYSTEMS

- Detailed plans and specifications for a military base potable water distribution system. The design work encompassed instrumentation and control systems for the operation

of deep well pumps and associated control valves, as well as chlorination of the potable water, metering of flows, and water residual analysis.

- Detailed plans and specifications for modifications to municipal potable water system. The instrumentation and control systems design work encompassed both analog and discrete instrumentation and controls using a frequency shift tone telemetering system over leased telephone lines.

MISCELLANEOUS PROCESSES

- Detailed design of large turbine-driven refrigeration machine instrumentation and control systems. Miniature electronic hardware for flow, pressure, temperature, and vibration monitoring and control were applied for this project.
- Detailed design of burner management systems for three No. 6 fuel oil-fired vertical Dowtherm heaters. Conventional relay logic was used in the design for these systems.

ENVIRONMENTAL ANALYSIS AND PLANNING

Specific examples of recent projects accomplished by Stanley Consultants are provided below. The example projects reflect the total environmental and economic expertise that can be brought to bear to ensure an efficient and appropriate analysis of environmental problems. The referenced projects reflect changing environmental requirements and growing expertise within Stanley Consultants. They also illustrate the diversity of environmental concerns which have been successfully evaluated in addition to the environmental assessments completed for water quality management. Stanley Consultants has accomplished many different types of environmental, social, and economic analysis projects, not just one type of project many times.

Golden Valley Electric Association; Alaska

Work has been completed on a site selection study and environmental assessment for a 150 MW coal-fired unit in interior Alaska. The site selection study included an evaluation of air quality, water quality, and natural resources to determine the feasibility of expansion at an existing site or construction at one of two other locations. An environmental assessment was prepared for the new unit and at least 40 miles of transmission line routing. Extensive air quality, terrestrial, and aquatic studies were performed. Comprehensive state and federal agency contacts were maintained throughout the study.

Muscatine Power and Water; Iowa

The city of Muscatine, Iowa, has retained SCI to provide total planning, environmental, and design services for a proposed 150 MW coal-fired generating facility.

Air quality monitoring stations have been set up in accordance with U.S. Environmental Protection Agency and Iowa Department of Environmental Quality guidelines. One year of air quality data has been collected and compiled for submittal for a Prevention of Significant Deterioration Permit.

An environmental analysis has also been completed on this project and submitted to the U.S. Army Corps of Engineers, Rock Island District, for their review and approval. Major work elements for the environmental analysis included the following:

- Air quality monitoring
- Air quality modeling
- Survey of biological impacts
- Malacological investigations
- Historical/Archaeological surveys

To date, permit applications have been filed for a variety of permits including Section 404 and Section 10 permits. A Section 316(a) Thermal Demonstration was prepared and approved by U.S. Environmental Protection Agency for a thermal variance to the National Pollution Discharge Elimination Standards (NPDES) permit.

SCI provided the client assistance in preparing an application and obtaining their operation permit from the Iowa Commerce Commission.

City Utilities of Springfield, Missouri - Power Supply Study

Stanley Consultants has been retained to develop a power supply plan to meet future area energy demands. Concurrently, an environmental investigation is being completed to determine if new power generating facilities can be built in the Springfield area and still meet all local, state and federal environmental regulations.

A parallel study is also being prepared to determine if wastewater from the nearby municipal wastewater treatment plant can be used as cooling water. Investigations of potential purchase/sales arrangements with other utilities in the Midwest are also being made.

Seminole Electric Cooperative; Florida

This project, completed in April, 1977, consisted of identification of locations within Florida suitable as sites for two 600 MW coal-fired generating units. The entire state was examined to identify zones where adequate water supply, transportation facilities, and transmission lines intersect. These zones were then modified by environmental constraints which were identified through contacts with state and federal agencies. A map overlay system was used to reduce the zones to search areas which contained suitable power plant sites. Initially, 53 locations were identified and ultimately these were reduced to 11. An option has been taken on one of the sites and efforts are underway to secure an alternative to the prime site. This study won the first place award in the Consulting Engineers Council of Georgia's 1978 competition.

Allied Power Cooperative; Iowa

This study consisted of identification and evaluation of locations containing sites suitable for two 600 MW coal-fired generating units to be constructed by a group of rural electric cooperatives, municipal systems, and possibly investor-owned utilities. The entire state of Iowa was examined to ascertain zones where adequate water supply, transportation facilities, and transmission lines meet. These zones were then modified based upon environmental constraints resulting in search areas which ultimately contained power plant locations. Numerous contacts with state and federal agencies were made to identify concerns about power plant locations in Iowa. Initially, 56 locations were identified. These 56 were ultimately reduced to 10 locations. Three

sites were selected from the 10 locations. Efforts to secure options on the primary site and two alternates are under way.

East Kentucky Power Cooperative; Kentucky

An environmental analysis of a 500 MW, coal-fired electric generating unit and 68 miles of 345 kV transmission line. Favorable and adverse effects of the proposed generating station and line were evaluated, and alternatives were studied. Analysis included the effects on natural and cultural resources and on anticipated community development patterns.

The Cleveland Electric Illuminating Company; Ohio

Environmental analyses and corridor studies of alternative routes were prepared by Stanley Consultants for a 345 kV, double-circuit transmission line in northeast Ohio. Analysis included the expected impact of alternative structure design and line locations on natural and cultural resources and on anticipated community development patterns. Recommendations were made for optimum routing, line configuration, structure type, and right-of-way treatment. Underground transmission was considered as one of the alternatives.

Northern Michigan Electric Cooperative, Inc.; Michigan

A pollution control study of two existing 7.5 MW units and a new 22 MW electric generating unit, all firing pulverized coal was conducted by Stanley Consultants. The purpose of the study was to recommend methods to limit pollution around the Advance, Michigan, power plant and within the power plant building caused by sulfur dioxide and particulate emissions from boiler stacks. Recommendations included installation of one new stack to serve two units and the addition of electrostatic precipitators on all three units to limit particulate emissions in conformance with Michigan Air Pollution Regulations.

U.S. Fish and Wildlife Service; Twin Cities Office

Environmental assessment for the ten units of the Mark Twain National Wildlife Refuge located on the Illinois and Mississippi Rivers in Illinois, Iowa, and Missouri. Social, economic, and environmental impacts of proposed improvements to and continued operation of the refuge were analyzed. Detailed wildlife and archaeologic studies were completed along with extensive economic benefit analyses.

U.S. Army Corps of Engineers; New Orleans District

Environmental analysis and preparation of the preliminary draft of an Environmental Impact Statement for the operation and maintenance of the Mississippi River-Gulf Outlet (MRGO) and associated bayous located in the vicinity of Lake Borgne, Louisiana. The MRGO is a navigation channel 500 feet wide by 36 feet deep with a length of 76 miles. The study included descriptions of environmental and socioeconomic settings, operation and maintenance practices and their effects on the environment, and the planning process for future operation and maintenance work.

U.S. Soil Conservation Service; Minnesota

Inventory and evaluation of present and future environmental and socioeconomic conditions of the South Zumbro Watershed of southeast Minnesota. Projections were based upon two alternatives: the proposed P. L. 566 watershed and flood protection plans or an assessment of future conditions without the plan.

U.S. Postal Service, Central Regional Office; Chicago, Illinois

Environmental assessment and environmental impact analysis for the proposed relocation of a major mail processing facility from the south side of Chicago to a western suburb. Emphasis in this study was placed upon the socioeconomic impact in the relocation of 1,000 minority jobs within the metropolitan area. Other considerations

included assessment of air and noise pollution, impacts on the land use pattern, housing conditions, and the provision of community services.

Ohio Environmental Protection Agency; Columbis, Ohio

Study of environmental considerations involved in the development of solid waste resource recovery facilities in municipalities throughout Ohio. Potential impacts on the environment and well-being of workers near a solid waste recovery facility were analyzed. These factors included aesthetics, environmental health, air and water pollution, and intangible environmental impact.

U.S. Army Corps of Engineers; Rock Island District

Environmental impact analysis for a proposed levee system to provide areawide flood protection from the Rock and Mississippi Rivers for portions of East Moline, Illinois, and Rock Island County. This study included evaluation of social and economic trends, as well as an evaluation of the biotic community in the area.

U.S. Army Corps of Engineers; Kansas City District

Environmental analysis and effect assessments for the Grand River Basin in Missouri and Iowa. Social, economic, and environmental effects of two reservoirs, of eight alternative flood retarding structures, and systems of levee improvement were assessed. A public opinion poll regarding the project was also conducted in the area by SCI staff.

City of Fort Madison, Iowa

Environmental assessment for secondary wastewater treatment plant improvements. Analysis was made of the environmental setting of the project and the probable impacts of treatment plant improvements and alternatives. The proposed improvements are located on a site adjacent to the Mississippi River and surrounded by residential, commercial, and industrial land uses.

U.S. Army Corps of Engineers, Detroit District

Feasibility, economic analysis, environmental analyses, and design outline for alternative flood protection facilities in Monroe, Wayne and Macomb Counties in Michigan. This study included an evaluation of existing conditions in the Detroit metropolitan area and rural areas to the south. Local land use plans, environmental, and economic considerations played heavily in the selection of the selected alternative.

Southeastern Wisconsin Regional Planning Commission; Waukesha, Wisconsin

Environmental investigations relating to point source control, urban storm water run-off, agricultural run-off control, and sludge disposal alternatives. These studies were conducted as a part of the region's Section 208 water quality management program. Included were studies of cost, resource use, performance of systems, and applicability of potential processes to various pollutant sources in the region.

U.S. Army Corps of Engineers; New Orleans District

Environmental and economic analysis of alternative regional water quality management facilities for a 10,000 square mile area (20 parishes), including New Orleans. This environmental study was conducted in conjunction with management plans and programs recommended in an overall urban study. Alternatives investigated included maximizing use of existing wastewater treatment facilities, combination of existing and regional facilities, and combined municipal-industrial treatment.

U.S. Army Corps of Engineers; Huntington District

Comprehensive economic analysis for the five-county Huntington-Ashland-Portsmouth Region in West Virginia, Kentucky, and Ohio. The study used computer-assisted techniques to establish four relative economic baseline scenarios for the region. Projections were made

of earnings, employment, and output using the National Income and Product Accounts of the United States and a variety of other sources of data. Study results were used as a partial base for the analysis of water quality management alternatives for the region.

City of East Moline, Illinois

Environmental assessment for expansion of a regional sewage treatment plant. An evaluation of the environmental setting included soil investigations, analysis of potential flooding, and assessment of water quality criteria. A determination of potential impacts of sewage treatment plant expansion on the environmental setting and development patterns in the area was made.

Alabama Water Improvement Commission; Montgomery, Alabama

Water quality management and planning programs for the Black Warrior River Basin. Study elements involved all the major factors required for an effective basin planning program including natural environmental characteristics, socioeconomic and land use characteristics, beneficial water uses, nonpoint water pollution sources, point wastewater sources, water quality, and waste load allocations. The study was utilized to establish NPDES permit requirements and provides a basis for determination of water quality management alternatives and programs.

U.S. Army Corps of Engineers; Mobile District

Study of alternative uses for a 60-mile reach of the Upper Flint River, south of Atlanta, Georgia. Three alternative uses were considered: (1) the development of the stream and its environs as a scenic river; (2) the designation and preservation of the stream as a scenic river under the state of Georgia's Scenic Rivers Act of 1969, and as a National wild and scenic river under the National Wild and Scenic Rivers Act; and (3) development in an uncontrolled manner by the private sector. This study was prepared as an input for an

environmental impact statement on a multipurpose dam and regulation pool, evaluating the need and economic feasibility of alternative uses for this resource.

Water Resources Projects

LOWER DES PLAINES VALLEY WATER RESOURCES COMMITTEE, JOLIET, ILLINOIS

Comprehensive water resources study covering 600 square miles southwest of Chicago having a 50-year projection of 700,000 population and 120 million gallon per day water usage, considering deep and shallow aquifers and surface waters (including Lake Michigan) leading to recommendation of water transmission from the Kankakee River, together with financing and management structures to meet the water requirements.

LAKE ERIE WATERSHED CONSERVATION FOUNDATION, CLEVELAND, OHIO

Study and report of present and future domestic and industrial water demands covering a 3,100 square mile, 8-county area around metropolitan Cleveland and Akron, including investigation of all water resources and recommendation of water supply augmentation by pumping from Lake Erie to provide for an estimated 2.7 billion gallon per day deficiency in the year 2000.

DEPARTMENT OF NATURAL RESOURCES, STATE OF OHIO

Water inventory studies on the 8,000 square mile Muskingum River Basin considering flood problems, water use, pollution control, land use and potential development of multi-purpose reservoir sites.

Feasibility study and report, including cost estimates, for the rehabilitation of dams and locks on the Muskingum River to re-establish river navigational potential.

Survey and report on development of 26,000 acres of state reclamation lands in Perry, Jefferson, and Harrison Counties for wildlife habitat and improvements of new and existing impoundments for sport fish production.

A report summarizing data and information related to the origin and control of acidic drainage to Lake Hope, Vinton County, Ohio, from tributary watersheds. The nature of pollution control techniques evaluated for possible improvement of the water quality included: mine sealing, inundation of reactive materials, diversion of uncontaminated surface waters, and neutralization of acidic drainage. The initiation of an immediate pollution abatement program, including mine sealing, was recommended.

Preliminary study and inventory of acid mine drainage in Lake Hope watershed including monitoring of quality and quantity leading to recommended improvements for mine pollution abatement.



DEPARTMENT OF NATURAL RESOURCES, STATE OF OHIO (Continued)

Preparation of a feasibility study under Water Pollution Control Research Series 14010 for Lake Hope, Vinton County, Ohio. Recommendations included a multi-stage mine sealing program with the ultimate goal of reducing acid mine drainage from abandoned underground workings to an acceptable level. Preliminary engineering was accomplished on the method of sealing a total of 107 mine openings.

Report on acid mine drainage from State-owned surface-mined lands in Perry County, including sources and concentrations of acidic runoff and hydrological characteristics of area, to recommend immediate and long range plans for pollution abatement and step-by-step plan for land reclamation. A series of programs were developed for the Perry County lands following these general guidelines, including provisions for a large wilderness type recreation area.

Investigation and study of erosion along a selected reach of the Lake Erie shoreline in Ohio. Contributing causes of beach and shore erosion were analyzed and recommendations made for methods of protection and cost alternatives for remedial works. The report included a "self-help protection plan" to encourage construction of gabion sea walls by private land owners. This pilot study is part of a comprehensive study and master plan for erosion protection along Ohio's Lake Erie shoreline.

A study with recommendations to direct the development and management of the Northeast Ohio Water Development Program. Major topical categories of investigation included in "The Background for Planning" were water supply, water quality and pollution control, water reclamation and reuse, erosion and flood control, solid wastes, regional growth, and recreation. The program directive was designed based on investigative studies and reviews with numerous levels of government and regulatory agencies.

Consultant for engineering and planning to the State of Ohio with liaison, review, and coordination responsibilities in various phases of the Great Lakes Basin Commission Framework Study of water and related land resources.

Study and report on the preservation and conservation of approximately 7,000 acres constituting the Killbuck wildlife area--the largest remaining inland marsh in Ohio. The recommended development program includes water quality upgrading, restoration of balance between open water and the timber and brush covered marsh, and wildlife habitat improvement.

Analysis and recommendation that a 60-mile section of the upper reaches of the Sandusky River in Northern Ohio be designated as a "Scenic River." River access points, stream side controls, and recreation centers were recommended.

Study and report covering sections of the Tuscarawas River and the Ohio and Erie Canal for development as a recreation parkway. The report included a review of water quality of the Canal and River systems extending over 35 miles.

DEPARTMENT OF NATURAL RESOURCES, STATE OF OHIO (Continued)

Preparation of a long range state-wide plan in outdoor recreation for the 88 counties comprising the State of Ohio. The project included a full inventory of existing facilities at the public and private level; projection of future demand for various types of recreation facilities, including identification of resource areas; and examination of existing and proposed improvements, including reservoirs, flood control projects, low flow augmentation programs and water quality improvement proposals.

An Urban Systems Engineering Demonstration Program was developed by Stanley Consultants for a portion of the Western Suburban Cleveland Metropolitan Area. This program received substantial federal funding under Section 701 (b) of the Housing Act of 1954 administered by the Department of Housing and Urban Development.

The program developed, through sophisticated computer applications, a storm drainage and flood control system for the study area. Potential damages due to flooding provide the major determinant of benefits for the various improvements considered. An optimal system was developed considering all program costs in relation to the benefits derived. Effects of improvements on water quality and development of financing and administrative options for plan implementation were all integral elements of the system analysis approach.

ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D. C.

Study and report, including evaluation, feasibility and preliminary engineering for a workable acid mine drainage abatement program along the upper Meander Creek of Mahoning County, Ohio. A recommended program to provide improvements in the aquatic environment of the Creek, and aesthetic benefits of the mined land and the corridor along the waterway draining the area included elimination of standing pools of acidic water, regrading to provide positive drainage, planting of acid tolerant grasses, plants and trees, and implementation of beneficial land use features.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, EAST LANSING, MICHIGAN

Preparation of plans and specifications for 25 miles of levees for farm land protection and associated drainage network. An evaluation was made of alternative pumping station locations and methods for collecting interior drainage. Instrument survey and subsurface investigations were performed along with the hydrologic and hydraulic analysis required to update two watershed work plans and design improvements on the Upper Maple River and tributaries.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLUMBUS OHIO

Engineering and planning investigation with report preparation on the watershed work plan for flood control in the Beaver Creek Watershed, an area of 118,000 acres located in northwest Ohio. Project included extensive application of computer analysis for hydrology and hydraulics as well as development

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, COLUMBUS,
OHIO (continued)

of cost-benefit information from hydraulic-economic evaluations. Assessment of environmental impact was critical to all project development. Measures required to prevent or offset environmental damage were included in the final work plan.

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE,
DES MOINES, IOWA

Survey and design of channel improvements and installation of relief lines, replacements, and extensions to public drain tile systems in the Deer Creek Watershed District, Worth County, Iowa.

OHIO DEPARTMENT OF HEALTH, COLUMBUS, OHIO

Provision of staff support to the Department in the preparation of the portion of the Water Quality Control Appendix covering the Ohio portion of the Great Lakes and Lake Erie Basin as part of the Great Lakes Basin Commission Framework Study. The work included descriptions of existing water quality and trends in quality; the relation of quality to uses; the identification of major problems at various locations within the study region; and the determination of general cost estimates for treatment of projected municipal and industrial waste loads.

FEDERAL INSURANCE ADMINISTRATION, DEPARTMENT OF HOUSING AND URBAN
DEVELOPMENT, WASHINGTON, D. C.

Provision of the necessary hydrological data and zone maps needed to establish flood insurance rates for Rocky River, Ohio, as a participant in the National Flood Insurance Program. Exposure to flooding in the city from Rocky River, Spencer Creek, and areas of inadequate storm sewers was investigated. Development included establishing flood frequencies from annual peak discharges, selecting cross-sections and roughness coefficients, and completing backwater analysis using the Corps of Engineers' computer program to identify flood profiles. Flood hazard factors were then determined and flood zones delineated along with recommendations for floodway widths. In addition to the above, this engagement included a general review of various hydrologic features of the National Flood Insurance Program for the client.

Flood insurance studies for the following Wisconsin communities: Buffalo County, Pepin County, Trempealeau County, City of Alma, Village of Stockholm, and Village of Trempealeau. These studies included instrument survey of channel cross-sections, gathering data from governmental agencies, and the required hydrology and hydraulic calculations for preparation of flood insurance zone maps and related documents. The project covered a total of 68 river miles, most of which was on the Mississippi River.

DEPARTMENT OF METROPOLITAN DEVELOPMENT, INDIANAPOLIS, INDIANA

The Indianapolis Department of Metropolitan Development has undertaken preparation of a comprehensive water quality control plan for the eight-county metropolitan area. The program is partially funded under Section 3 (c) of the Federal Water Pollution Control Act. The Indianapolis study is part of a statewide water quality control plan and encompasses a current population of 1,100,000 people in central Indiana.

Stanley Consultants are serving as the prime technical consultant in the development of the water quality management plan and are using four other consultants as subcontractors in the data collection phase of the program.

A complete inventory of all potential sources of pollution as well as existing pollution abatement facilities will be undertaken. Following full evaluation of all data collected, the comprehensive plan will be formulated. All aspects of the program are subject to the review and guidance of a Water Quality Control Committee organized to assist in data collection and to provide local input to the planning process.

MIAMI CONSERVANCY DISTRICT, DAYTON, OHIO

Three-year study analyzing potential of five large flood retention reservoirs from 250 to 1,200 acres surface area, considering flood frequency, adjacent land use, recreational potential and access.

WESTERN NIGERIA WATER CORPORATION, IBADAN, NIGERIA

Complete management and operational control of the water system for the 1,000,000 inhabitants City of Ibadan. Stanley Consultants has served as management consultants to the Corporation since 1964.

DEPARTMENT OF DEVELOPMENT, STATE OF OHIO

Feasibility study of water transmission from Lake Erie to serve the Maumee River Basin, involving up to 240 miles of 48" to 72" transmission mains.

U. S. ARMY CORPS OF ENGINEERS

General design memorandum supplement, detailed design memorandum, plans and specifications for Rigolets Lock, channel and barrier embankment--a portion of the Lake Pontchartrain hurricane protection plan--(joint venture with B. M. Dornblatt and Associates, Inc.).

Feasibility study on flood control, drainage and related operations involving 720 square mile watershed, considering combinations of reservoirs, diversions, levees and channel improvements on the 73 mile long Cache River in Illinois.

Report on improvements to a 50-mile reach of the Paint Rock River, Alabama, including removal of existing dam structures and determination of economic benefits.

U. S. ARMY CORPS OF ENGINEERS (continued)

Design memorandum and final plans for levee improvements, pumping plant capabilities, routing of flood flows through tributary streams and under-seepage analysis and control on a 10-mile reach of the Mississippi River in the Drury Drainage District located in Western Illinois.

Flood plain information report and brochure on the South Fork Zumbro River and tributaries in the vicinity of Rochester, Minnesota, involving approximately 40 river miles and a 300 square mile drainage area.

Flood plain information report and brochure on the Mississippi River and tributaries near LaCrosse, Wisconsin, involving approximately 20 river miles and a 480 square mile drainage area. A history of past floods was compiled and probable future floods were analyzed to enable the City of LaCrosse to arrive at solutions to minimize vulnerability to flood damages.

General Design Memorandum, Souris River channel improvement, above, through and below Minot, North Dakota, involving 40 river miles of channel which has a gross drainage area of 11,300 square miles and contributing area of 4,200 square miles. Project consists of hydrologic and hydraulic analyses; topographic surveys; soils investigations; recommendations for channel realignments, clearing, snagging, and dike construction; preliminary plans for the reconstruction or modifications of 23 bridges; and environmental impact statement.

Flood plain information report and brochure on the Wisconsin River through Wood County, Wisconsin covering approximately 22 river miles and a drainage area of approximately 5,400 sq. miles. Five low head dams are within the study reach.

Flood plain information report and brochure for approximately four miles of the Ontonagon River in the vicinity of Ontonagon, Michigan, involving approximately 1,400 square miles of drainage area and a shoreline erosion study for approximately 25 miles of Lake Superior shoreline in the vicinity of Ontonagon, Michigan.

Flood plain information report and brochure on the East River and tributaries in the Green Bay, Wisconsin, area. The study encompasses approximately 19 stream miles and 147 square miles of drainage area.

Flood plain information report and brochure for approximately 5 1/2 miles of the Wisconsin River in the vicinity of Stevens Point, Wisconsin, involving approximately 5,000 square miles of drainage area. Two low head dams were within the study reach.

Flood plain information report for streams in the vicinity of Luverne, Minnesota, using the HEC-2 computer program, involving approximately four river miles and a 430 square mile drainage area.

U. S. ARMY CORPS OF ENGINEERS (continued)

Flood Insurance Study covering approximately 18 miles of stream channels in the urban areas of the City of Baltimore, Maryland. Services included field surveys, hydraulics of existing conditions, flood zone determination, flood-way determinations, mapping and final report all in accordance with the format established in "Guidelines for Type 15 Flood Insurance Studies."

Study of alternative uses for the Upper Flint River in the State of Georgia. Three alternative uses were considered: (1) the development of the stream and its environs as a scenic river park; (2) the designation and preservation of the stream as a scenic river under the State of Georgia's Scenic Rivers Act of 1969, and as a national wild and scenic river under the National Wild and Scenic Rivers Act; and (3) abandonment of all plans and reliance upon private interests to meet outdoor recreation needs of the associated market area. This study was prepared as input for an environmental impact statement on a multi-purpose dam and reregulation pool on the Upper Flint River, evaluating the need for and the economic feasibility of alternative uses for this resource.

Detailed Project Report evaluating alternative flood protection measures and levee systems on the Little Sioux River at Spencer, Iowa, drainage area 1,100 square miles. Study and report covers field survey and reconnaissance, hydrologic and hydraulic analysis, preliminary and final design and project formulation, and an assessment of social, economic and environmental impacts of project and draft impact statement.

Flood plain information reports and brochures for Cass and Wabash Counties in Indiana, including the cities of Logansport and Wabash. Studies were made on the Wabash River, Eel River, and Goose Creek for a total of 50 stream miles and a drainage area of 3,780 square miles. Backwater studies were conducted using Corps of Engineers HEC-2 computer program. Instrument survey of channel cross-sections was performed along with field reconnaissance of the study area.

Special flood hazard information studies for the City of Excelsior Springs, Missouri, including 4 stream miles on East Fork and Dry Fork Fishing Rivers. Instrument survey and field reconnaissance were provided, along with hydrologic and hydraulic studies to outline flood potential for this city.

Water resource study to update and expand a review report on Fishing River and tributaries at Excelsior Springs, Missouri. Economic computations were performed to determine benefit-cost ratios for various flood control measures on this 25 square mile drainage basin. Non-structural measures were also evaluated and recommended.

U. S. ARMY CORPS OF ENGINEERS (Continued)

Preparation of a plan of development for environmental enhancement of the Clarence Cannon Dam, including spillway and power house and a corridor extending two miles downstream from the main dam. Enhancement involved topography and land forms, wildlife habitat, and ecological context; architectural treatment for the major structures; and recreational facilities and access roads.

Design and engineering supervision of construction of a river channel change on the Big Sioux River in connection with the U. S. Air Corps Technical School, Sioux Falls, South Dakota.

GOVERNMENT OF NORTHERN NIGERIA, KADUNA, NIGERIA, WEST AFRICA

Feasibility studies, reports and preliminary design of water supply facilities, including investigation of water resources, to serve total population of 220,000, for Ministry of Works.

CITY OF CARBONDALE, ILLINOIS

A \$10,000,000 comprehensive program of planning and design for the construction of facilities for water resources, transmission treatment and distribution, including:

Water Distribution System Improvements - computer analysis and report on needed improvements to the water distribution system and design of improvements.

Water Resources Study - an evaluation of eleven potential water supply sources, including ground water, side channel reservoirs, stream impoundments, and inter-city water systems, to develop the most economical long range supply of adequate volume to the year 2000.

Cedar Creek Dam and Reservoir - report and design for construction of two earth dams impounding a 1750 acre multi-purpose reservoir providing 41,500 acre feet of storage for a water supply yield of 16,000,000 gallon per day based on 30 year drought conditions. Dam design considered protection against failure during severe intensity earthquake.

Design of emergency repairs to concrete spillway of the existing Carbondale Reservoir to eliminate an underflow threatening failure of the structure.

Raw Water Pumping and Transmission Facilities - report and design of raw water pumping station and pipe line to existing intermediate storage reservoir. A second project involved design of raw water intake at the existing reservoir and a raw water pipe line to the existing water treatment plant.

CITY OF CARBONDALE, ILLINOIS (continued)

Water Treatment Facilities - report and design of new 8,000,000 gallon per day water treatment plant, arranged for future expansion to 24,000,000 gallon per day capacity, including a 250,000 gallon treated water storage tank.

IOWA GREAT LAKES, OKOBOJI, IOWA

A study program was developed to encompass all elements of water quality management for the Iowa Great Lakes area in Dickinson County, Iowa. The program involved coordination of efforts by Soil Conservation agencies, Iowa Conservation Commission, Iowa Geological Survey, local municipalities and sanitary district, two state universities, and special consultants in limnology and aquatic biology.

CITY OF RITTMAN, OHIO

Feasibility report evaluating potential of impounding reservoirs, wells and off-channel storage as resources for municipal water system.

MINISTRY OF AGRICULTURE AND NATURAL RESOURCES, KADUNA, NIGERIA, WEST AFRICA

Resource studies and investigations involving irrigation and agricultural development of over 175,000 acres in the Karadua River basin. The project also included feasibility studies on the construction of a series of earth dams to create reservoirs for the irrigation water supply.

CITY OF MEDINA, OHIO

Water resource study, site selection, design and specifications for 7,000-foot earth dam, 28 feet high, to create 1,700 acre-foot off-channel storage reservoir and pumping station to supply 4 million gallons per day of water for municipal water supply.

CITY OF GRAFTON, NORTH DAKOTA

Feasibility study forecasting municipal water supply demands for 25 years from projections of domestic, commercial and industrial consumers and recommendations of off-channel storage reservoir to satisfy requirements.

MUSCATINE POWER AND WATER, MUSCATINE, IOWA

Study and report on the potential of the present Muscatine Island water supply and performance of an economic comparison of several different methods of developing new sources of water for a 105,000,000 gallon per day supply.

CITY OF NEWTON, IOWA

Study and report for feasibility of expanding municipal water supply to meet future demands and recommendations for expansion of shallow well system.

EAST KENTUCKY RURAL ELECTRIC COOPERATIVE CORPORATION, WINCHESTER, KENTUCKY

Report, design and plans and specifications for construction of a cooling water intake and subsequent enlargement for the Cooperative's 300,000 kw John Sherman Cooper power plant located near Burnside, Kentucky. The level of water from Lake Cumberland used for cooling water can vary approximately 90 feet during the course of a year. A head recovery system was designed utilizing hydraulic turbine drive head recovery pumps in conjunction with motor driven variable speed vertical pumps to solve this challenging problem.

CITY OF CHARITON, IOWA

Report, design and construction supervision of an earth dam 1,150 feet long, 28 feet high, with concrete spillway, for a 900 million gallon impounding reservoir for municipal water supply.

THE MIDDLETOWN HYDRAULIC COMPANY, DAYTON, OHIO

Preliminary engineering, planning, and report on present condition and development potential of Company owned canal and control facilities in Middletown, Ohio. Recommendations included the potential of the canal and adjacent Company owned property as a recreational resource compatible with industrial water supply functions.

MAIDUGURI, NIGERIA, WEST AFRICA

Investigations relative to a proposed 9,000,000 gallon per day water supply for Maiduguri, Nigeria, involving shallow deposits along the Ngadda River, the upper artesian aquifer and the lower artesian aquifer, as well as surface water supply.

ROSS COUNTY, OHIO

Design and construction supervision of an earth dam 700 feet long, 50 feet high, with service and emergency spillways to form 100-acre lake for wildlife and recreational purposes.

GREEN VALLEY LAKE, UNION COUNTY, IOWA

Design and construction supervision of earth dam 1,020 feet long, 83 feet high, with concrete spillway, to form 400-acre lake for municipal water supply, power plant cooling water and recreational purposes.

GEODE STATE PARK, BURLINGTON, IOWA

Report, design and construction supervision of an earth dam 1,180 feet long and 54 feet high, with concrete spillway, to create 190 acre lake.

CEDAR RIVER DAM, WAVERLY, IOWA

Report, design and engineering supervision of construction for rebuilding an existing concrete dam, including a new fish ladder, retaining walls, electric duct-ways and reconstruction of flood gates.

REPUBLIC OF DAHOMEY, WEST AFRICA

Design, purchasing, inspection of materials, and supervision of construction for a 15-town rural water resources development program. The project included water treatment plants, pumping stations, ground and elevated storage tanks, and distribution piping, together with a training program for local personnel who will be operating the systems.

CITY OF LAMONI, IOWA

Report, design, plans and specifications for an earth dam 1,100 feet long and 34 feet high and 200 million gallon impounding reservoir for municipal water supply.

REPUBLIC OF LIBERIA, MONROVIA, LIBERIA

Ascertain the navigational potential of a 13-mile stretch of the Lofa River in Liberia from its mouth at the Atlantic Ocean. The work consisted of the investigation, survey and preparation of navigation charts for a suitable channel to permit travel by ocean-worthy vessels of the 500-ton class as a part of the Republic of Liberia program of economic development of remote areas of the country.

CITY OF MOBERLY, MISSOURI

Survey and mapping of existing reservoir and report, design and construction supervision of a new dam 1,150 feet long and 46 feet high to increase reservoir capacity to 2 billion gallons for municipal water supply.

CITY OF GREENFIELD, IOWA

Comprehensive report on improvements to an existing impounded water supply for the municipal water system.

LORAIN COUNTY METROPOLITAN PARK DISTRICT, ELYRIA, OHIO

Report on feasibility of utilizing a proposed highway embankment as a dam to create a 680-acre reservoir for water supply, recreation and limited flood control purposes. A bridge and dam (highway embankment) were subsequently designed.

SCOTT COUNTY CONSERVATION BOARD, DAVENPORT, IOWA

Subsurface survey and feasibility report on construction of water-tight impounding reservoir in county park. Studies concluded underground formations not suitable for an economical dam and reservoir construction.

KNOXVILLE, IOWA

Comparison of shallow sand aquifers versus deep sandstone wells leading to selection of the latter.

COLORADO-UTE ELECTRIC ASSOCIATION, HAYDEN POWER STATION, MONTROSE, COLORADO

Investigation, report, preliminary designs and cost estimates on feasibility of developing a 5,000 acre-foot off-channel storage reservoir for low flow augmentation.

Design, specifications and construction supervision of earth dam and combination 161 million gallon water storage reservoir and 147 million gallon ash slurry impoundment.

THREE RIVERS WATERSHED DISTRICT, LAKE ERIE WATER CONSERVATION FOUNDATION, CLEVELAND, OHIO

Report on water quality and use for Rocky, Chagrin and Cuyahoga Rivers in Cleveland metropolitan area, including hydrological study, present and future land and water uses, and proposed stream water quality criteria for use in establishing a sound program of water quality management and appropriate standards.

ATLANTIC RICHFIELD CO., SINCLAIR OIL CORP. SUBSIDIARY; NEW YORK, NEW YORK

Evaluation of new plant site for effect of waste materials on underground aquifer.

UNITED STATES STEEL CORPORATION, PITTSBURGH, PENNSYLVANIA

Perform water quality studies of the Black River at Lorain, Ohio.

Perform water quality and use studies for the Lorain Works.

Perform water quality and use studies for the Central Furnaces, Cleveland, Ohio.

MOUNT COFFEE HYDROELECTRIC PROJECT, LIBERIA, WEST AFRICA

Report, design, plans, specifications and engineering supervision of construction for three earth dams with total length of 2,530 feet, concrete spillway for 350,000 cubic feet per second with 10 tainter gates 35 feet high by 40 feet wide, creating a 2,000-acre impoundment with maximum depth of 70 feet for hydroelectric power generation station.

BOARD OF COMMISSIONERS, CUYAHOGA COUNTY, OHIO

Feasibility study of flood control works on the Cuyahoga, Chagrin and Rocky Rivers, including flood damage estimates, hydrological studies to forecast flood flows, evaluation of various flood control plans and resulting benefits, and recommendations for channel improvements, reservoirs and other structures and consideration of flood plain zoning in highly industrialized area.

KINGSTON HARBOUR, JAMAICA

Study of Rio Cobre, Rio Pedro, Sandy Gully and Duhaney River basins to determine frequency and intensity of floods. Sediment and bed load studies to determine effect of rivers on Kingston Harbour and recommendation of flood control program to reclaim flood plain areas for residential and industrial development.

BETTENDORF, IOWA

Plans and specifications to clear, straighten and widen approximately 7,000 feet of Duck Creek to provide 18,000 cfs capacity flood flows.

CITY OF CLEVELAND, OHIO

Study of causes of flooding in the University Circle area of Cleveland and recommendations for retention storage and improved runoff facilities.

Preliminary design of dam on Tinkers Creek for the Metropolitan Park District.

CITY OF MUSCATINE, IOWA

Design and engineering supervision of construction of Mississippi River levee improvements for flood protection.

WOODSTOCK, ILLINOIS

An investigation of potential groundwater shallow aquifer sites for municipal water supply using soils resistivity, borings, and test pumping to locate the most feasible source.

CRISP COUNTY POWER COMMISSION, CORDELE, GEORGIA

Study and report to establish the feasibility and best method of clearing dead timber from the existing 8,500-acre Lake Blackshear near Cordele, Georgia, to provide safe water areas for recreational purposes. The study included evaluation of clearing methods with and without lowering the lake level, including the loss of hydroelectric and steam power generation, and recommendation of navigation aids for cleared areas.

Air Quality Control Projects

EAST KENTUCKY RURAL ELECTRIC COOPERATIVE CORPORATION, WINCHESTER, KENTUCKY

Design and resident engineering services during installation of a hot side electrostatic precipitator with chevron arrangement and a collection efficiency of 99% for the Charleston Bottoms 320 MW pulverized coal-fired electric generating unit.

Study, report, design, and resident engineering supervision during installation of two electrostatic precipitators (99% overall collection efficiency) for the two-unit 354 MW John Sherman Cooper Steam Generating Station located near Burnside, Kentucky.

Study, report, design, and resident supervision during installation at the Cooperative's William C. Dale Steam Generating Station located near Ford, Kentucky, of two electrostatic precipitators on Units 3 and 4 (148 MW) and the conversion of Units 1 and 2 (46 MW) to oil firing. The overall collection efficiency of the station is 99%.

UNION CARBIDE CORPORATION, ALLOY, WEST VIRGINIA

Preliminary study, design, and installation of four electrostatic precipitators at 99.3% collection efficiency for four pulverized coal-fired electric generating units (three at 350,000 lb/hr each and one at 54,000 lb/hr steam).

Design and installation of four fume collection hoods and bag house collector installation for four ferroalloy electric furnaces ranging from 15 to 25 MW capacity each.

UNION CARBIDE CORPORATION, MARIETTA, OHIO

Preliminary study, design, and installation of four electrostatic precipitators at 98% collection efficiency for four 650,000 lb. each pulverized coal-fired electric generating units.

CENTRAL IOWA POWER COOPERATIVE, MARION, IOWA

Environmental analysis for repowering and air emission reduction program for existing 3-unit, 25 MW power plant. The analysis included assessment of the proposed project with respect to emission of particulates, sulfur dioxide, and nitrogen oxides, as well as changes in consumptive water use and sound pressure levels.



CENTRAL IOWA POWER COOPERATIVE, MARION, IOWA (Continued)

Design and installation in the Summit Lake Station of two 30 MW gas turbines and replacement of three existing coal-fired boilers with two unfired waste heat recovery steam generators.

Air emission control study to determine action required to achieve compliance with state and local pollution control regulation for two 22 MW steam electric generating units in the existing 223 MW Prairie Creek Station. Alternatives considered included retirement of the units, repowering, fuel conversion, combination fuel firing, application of electrostatic precipitators, and application of wet scrubbers.

BOARD OF WATER AND LIGHT, LANSING, MICHIGAN

Design and installation of an electrostatic precipitator with a collection efficiency of 99% was included for a 160 MW pulverized coal-fired electric generating unit in the Erickson Generating Station. A sulfur dioxide dispersion study was performed.

ALABAMA ELECTRIC POWER COOPERATIVE, ANDALUSIA, ALABAMA

Study, report, design, and resident engineering supervision during installation of a hot side electrostatic precipitator with rigid electrodes (99.3% overall collection efficiency) for the 66 MW Tombigbee Steam Generating Station located near Jackson, Alabama.

Study, report, design, and resident supervision during installation at the Co-operative's McWilliams Steam Generating Station located at Gantt, Alabama of one hot side electrostatic precipitator with rigid electrodes and 99.3% overall collection efficiency on the 25 MW Unit No. 3.

COLORADO-UTE ELECTRIC ASSOCIATION, INC., MONTROSE, COLORADO

Design and installation of mechanical dust collectors and an electrostatic precipitator for use in the Hayden, Colorado, plant to limit particulate emissions from the boiler stack on a 173 MW electric generating unit firing pulverized coal. The overall collection efficiency of this installation is 98.5%.

EMPIRE-DETROIT STEEL DIVISION, THE CYCLOPS CORPORATION, MANSFIELD, OHIO

Field investigation of total plant production facilities, operations, and existing air pollution control equipment which influence emissions to the atmosphere. Study and report estimating known emissions, alternate control methods for each source, priority and schedule for control equipment installation and recommendations on future testing and monitoring to meet present and expected federal, state, and/or local air standards.

EMPIRE-DETROIT STEEL DIVISION (FORMERLY REEVES-BOWMAN DIVISION), THE CYCLOPS CORPORATION, DOVER, OHIO

Field investigation of metal treating and fabricating plant production facilities and operations which influence emissions to the atmosphere. Study and report giving test and/or estimated emissions, alternate control methods for each source, priority and schedule for control equipment installation, and recommendations on future testing and monitoring to meet present and anticipated governmental air emission standards.

The study was followed by the design of internal air monitoring processes, increased ventilation of the galvanizing lines, and fume control equipment for the zinc pots.

EMPIRE-DETROIT STEEL DIVISION (FORMERLY REEVES-BOWMAN DIVISION), THE CYCLOPS CORPORATION, CARNEGIE, PENNSYLVANIA

Evaluation and written recommendations for removing fumes from the working areas of the steel strip cleaning and painting operations at the Carnegie Plant near Pittsburgh, Pennsylvania.

SOUTHERN ILLINOIS POWER COOPERATIVE, MARION, ILLINOIS

Environmental analysis for an existing 3-unit, 100 MW power plant. Study included a sulfur dioxide dispersion study and assistance with filing a stack emission control program.

Design and installation in the Marion Plant of three electrostatic precipitators with a collection efficiency of 96% for three 33 MW pressurized cyclone boilers. These cold side precipitators in combination with existing mechanical dust collectors result in an overall collection efficiency of 99%. Two of the precipitators were designed for erection on temporary foundations and roll-in to final location to minimize construction cost and unit down time.

EASTERN IOWA LIGHT AND POWER COOPERATIVE, WILTON, IOWA

Study, design outline, design, and resident inspection service during installation of two roof-mounted electrostatic precipitators providing a 99% overall collection efficiency for the two unit 55 MW Fair Station located near Montpelier, Iowa.

NATIONAL STARCH AND CHEMICAL CORPORATION, INDIANAPOLIS, INDIANA

Air pollution control study and report on the evaluation of alternative methods to bring the power house and feed dryer into compliance with existing particulate and sulfur dioxide emission control regulations.

NATIONAL STARCH AND CHEMICAL CORPORATION (Continued)

Design and installation of a roof-mounted 95% efficient electrostatic precipitator and three high efficiency mechanical dust collectors in series with existing mechanical dust collectors.

CORN BELT POWER COOPERATIVE, HUMBOLDT, IOWA

Study, design outline, design, and resident engineering inspection during installation of an electrostatic precipitator to provide 99% overall collection efficiency of particulate for a 33 MW unit at Earl F. Wisdom Generating Station located near Spencer, Iowa.

Study, design outline, design, and resident engineering inspection during installation of an electrostatic precipitator to provide 99% overall collection efficiency of particulate for a 15 MW unit at Humboldt Plant, Humboldt, Iowa.

MUSCATINE POWER AND WATER, MUSCATINE, IOWA

Design and installation of an electrostatic precipitator for use in the Muscatine Power Plant to limit particulate emissions from the boiler stack on the 83.5 MW electric generating unit firing crushed coal in cyclone furnaces. The collection efficiency is 95.2%.

Subsequent study of air pollution abatement for the entire plant including the unit above and three stoker-fired electric generating units of 25 MW, 12.5 MW, and 7.5 MW capacity. Study included methods to limit particulate emissions and investigations of alternates for SO₂ removal.

Design and installation of an electrostatic precipitator, two high efficiency mechanical dust collectors, and new chimney followed the study. The equipment which meets EPA requirements for allowable emissions has a combined collection efficiency of 92%.

CRAWFORDSVILLE ELECTRIC LIGHT AND POWER COMPANY, CRAWFORDSVILLE, INDIANA

Study and report to limit air pollution from three stoker-fired electric generating units (12.6 MW, 11.5 MW, and 7.5 MW). Included were recommendations to improve dust collector efficiency and a study of sulfur dioxide dispersion.

NORTHERN MICHIGAN ELECTRIC COOPERATIVE, INC., ADVANCE, MICHIGAN

A study of two existing 7.5 MW and a new 22 MW electric generating unit, all firing pulverized coal, to limit pollution around the Advance, Michigan, power plant and within the power plant building caused by sulfur dioxide and particulate emissions from boiler stacks. Recommendations included installation of one new stack to serve two units and the addition of electrostatic precipitators on all three units to limit particulate emissions in conformance with the Michigan Air Pollution Regulations.

NORTHERN MICHIGAN ELECTRIC COOPERATIVE, INC., ADVANCE, MICHIGAN (Continued)

This study was followed by design and installation of improvements to give a particulate matter collection efficiency of 98%. The improvements included the installation of an electrostatic precipitator and a new fluted Grecian column stack of corten steel to serve the two 7.5 MW units. A second precipitator was installed which serves the 22 MW unit.

CLINTON CORN PROCESSING COMPANY, CLINTON, IOWA

Design and installation of mechanical dust collectors to limit particulate emissions from boiler stacks of two existing steam generating units firing crushed coal in cyclone furnaces. Units are rated 275,000 and 330,000 lb/hr steam.

A subsequent air pollution abatement study of the entire boiler plant was performed including seven steam generating units ranging in capacity from 80,000 lb/hr to the units described above. Study included recommendations to add electrostatic precipitators for the cyclone-fired boilers, modifications and improvements to spreader stoker-fired units, and retirement of chain grate stoker-fired units. A stack dispersion study for sulfur oxides was also included. Design and roof-mounted installation of two electrostatic precipitators with 95% overall collection efficiency followed the report.

UNIVERSITY OF IOWA, IOWA CITY, IOWA

Perform a study including recommendations and budget for the installation of air pollution control equipment for the existing spreader stoker-fired steam generating units at the University Power and Heating Plant. Recommendations included installation of an electrostatic precipitator for two boilers, and retirement of four boilers.

This study was followed by the design and installation of an electrostatic precipitator to limit particulate emissions from a common stack for two-80,000 lb/hr spreader stoker-fired steam generating units. This equipment provides a combined collection efficiency of 99%.

COMMONWEALTH EDISON COMPANY, CHICAGO, ILLINOIS

Design and installation of oil conversion equipment for four coal-fired boilers rated 1,200,000 lb/hr to bring the existing Sabrooke Station, Rockford, Illinois, within the emission limits set by the Illinois Environmental Protection Agency.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, HAMPTON, VIRGINIA

Field examination, recommendations, and design for meeting air pollution standards from finishing and plating shops at the Langley Research Center. Recommendations were made for handling and treating exhaust gases from plating and finishing operations. Work performed included preliminary and final design, preparation of bid documents including drawings, specifications, and engineer's estimate and review during construction. The completed exhaust gases handling and treatment system brings the NASA Langley Research Center facilities within the federal and state air standards.

HUBINGER COMPANY, KEOKUK, IOWA

Study and report to include two high efficiency mechanical collectors and a new stack for sulfur dioxide dispersion for two spreader stoker-fired steam generating units.

MENASHA MUNICIPAL UTILITIES, MENASHA, WISCONSIN

Study, report, and design for modifications to an existing 30 MW steam generating plant to permit compliance with Wisconsin Air Pollution Regulations. Design covered installation of a dual chamber electrostatic precipitator with 90% overall collection efficiency and a new stack for two larger units with provision for emergency operation of two smaller units through a unique ducting arrangement.

GOLDEN VALLEY ELECTRIC ASSOCIATION, INC., FAIRBANKS, ALASKA

Review preliminary source testing results and provide engineering analysis and report on alternatives to meet the Alaska Air Quality Control Standards for emissions taking into account investment, operating cost, constructibility, and schedule of improvements for the 22 MW Healy Power Plant, Healy, Alaska.

AMERICAN MOTORS CORPORATION, MILWAUKEE, WISCONSIN

Study of a 100,000 lb/hr spreader stoker-fired boiler to determine the feasibility of converting to auxiliary gas/oil firing and/or installing pollution abatement equipment for stack gas clean-up. Recommendations included petitioning for a variance due to the existing energy crisis and future alternative plans. Cost estimates were developed for the alternates.

METROPOLITAN SEWER BOARD, ST. PAUL, MINNESOTA

Study and report on air emission control for four existing multiple hearth sludge incinerators at the Metropolitan Wastewater Treatment Plant, St. Paul, Minnesota. The purpose of the study was to recommend means of bringing odor and particulate emissions into compliance with regulations of the Minnesota Pollution Control Agency.

CLIFFORD-JACOBS FORGING COMPANY, CHAMPAIGN, ILLINOIS

A study, in accordance with the Illinois Air Pollution Regulations, with recommendations to reduce particulate and sulfur dioxide emissions from the stacks of four old spreader stoker-fired steam generating units in the manufacturing facilities for this client. Following recommendations made in the study, design was performed for the removal of three old boilers and replacement with two new 70,000 lb/hr package gas/oil fired type, along with conversion of an existing boiler to gas/oil firing.

VILLAGE OF WINNETKA, ILLINOIS

Study of conversion of the existing coal-fired steam generating plant consisting of five units rated 385,000 lb/hr to low sulfur oil fuel to reduce stack emissions to levels within the allowable limits set by the Illinois Environmental Protection Agency.

AMERICAN DISTILLING COMPANY, PEKIN, ILLINOIS

A study, in accordance with the Illinois Air Pollution Regulations, with recommendations and cost estimates, to reduce particulate and sulfur dioxide emissions from a common stack serving five stoker-fired generating units in the manufacturing facilities for this client. This study considered several alternates; the addition of dust collectors and gas scrubbers on the existing units; and installation of new gas/oil fired equipment. Recommendations included new gas/oil fired package boilers. Emissions from the boiler stack, together with two process stacks, were determined in accordance with the Illinois Air Pollution Regulations.

MT. PLEASANT MUNICIPAL UTILITIES, MT. PLEASANT, IOWA

Study to review rules and regulations of the Iowa Department of Health for allowable particulate and SO_2 emissions from the existing steam generating plant. Estimates of emissions from the existing equipment were made based on existing fuels and on possible alternate fuels. The study included recommendations for changes in operating procedures, fuels to be utilized, and improvements to be made to permit compliance with the Air Pollution Control Regulations.

WILSON & COMPANY, CHICAGO, ILLINOIS

Study and evaluation of proposed smoke abatement methods for packing plant smokehouses located in Southern California.

GENERAL

Sulfur dioxide dispersion studies have been performed with our computer to calculate the ground level concentration of SO_2 at a given location using parameters of sulfur content of the fuel, wind velocity and temperature, flue gas temperature, stack height, gas exit velocity, and distance from the stack to a selected point on the ground.

Typical Power Projects

Spurlock Generating Station; Maysville, Kentucky

Client: East Kentucky Power Cooperative; Winchester, Kentucky

Ultimate Capacity: 2,500 MW

Initial Installation: 320,000 kW (estimated operation July, 1976)

Fuel: Pulverized coal

Turbine: 2,400 psig/1,000 F throttle/1,000 F reheat

Coal Handling: By rail and river barge

Foundations: Long, high capacity, steel piling

Plant Addition: 530,000 kW (estimated operation April, 1980)

Fuel: Pulverized coal

Turbine: 2,400 psig/1,000 F throttle/1,000 F reheat

Coal Handling: By rail and river barge

Foundations: Long, high capacity, steel piling

John Sherman Cooper Station; Burnside, Kentucky

Client: East Kentucky Power Cooperative; Winchester, Kentucky

Ultimate Capacity: 700 MW

Initial Installation: 121,000 kW

Fuel: Pulverized coal

Turbine: 1,450 psig/1,000 F throttle/1,000 F reheat

Coal Handling: By river barge, rail, or truck

Foundations: Rock grouting under critical structures

Specialized head recovery principle on the circulating water system

Plant Addition: 233,000 kW

Fuel: Pulverized coal

Turbine: 1,800 psig/1,000 F throttle/1,000 F reheat

Coal Handling: By river barge, rail, or truck

Foundations: Rock grouting under critical structures

Circulating water head recovery arrangement

William C. Dale Station; Ford, Kentucky

Client: East Kentucky Power Cooperative; Winchester, Kentucky

Total Plant Capacity: 194 MW

This Extension: 148,000 kW (2 units)

Fuel: Pulverized coal

Turbine: 1,250 psig/950 F

Condenser Cooling: River water supply with river's edge spray cooling
for recirculated water



Commonwealth Edison Company; Chicago, Illinois

Architectural and structural design of a masonry control and low voltage switch-gear building at the 138-13.8 kV York Center Transmission Substation located at Oak Brook, Illinois. Civil design was performed of site layout, grading, foundations, and fencing to accommodate a new, modern, low profile standard structure and related equipment. Services also included electrical design for installation of grounding, duct banks, and cable trenches for a station with an initial capacity of two 33 MVA transformers arranged for an ultimate transformation capability of 200 MVA.

Structural design of a masonry control building at the 345-138 kV Nelson Substation near Rock Falls, Illinois. Layout and foundation design was prepared to accommodate a standard low profile 345 kV and 138 kV standard structure.

Study, report, and design covering three new electrode-type electric heating boilers including two 1,600 kW for the Chicago-North District Office Building and a 760 kW installed in the 12 kW switchhouse at Northwest Station.

Design of a new coal transfer plant at Havana, Illinois. This project includes provision of two 70,000-ton (live) stock out and storage piles, one for Illinois coal and one for low-sulfur western coal. Reclaim from either pile at the rate of 2,000 tons per hour is combined with car dumper output in any desired proportion to provide barge loading of blended fuel. The basic equipment is a traveling stacker-reclaimer with 3,000 TPH stock out and 2,000 TPH free digging reclaim capacity. Barge loading is by simultaneous feed from reclaim and car dumper with feed rate controls, interlocks, and weighed feedback.

Design of facilities for conversion of Sabrooke Station, Rockford, Illinois, to light oil firing for cyclic duty. This project includes the conversion of four existing coal-fired boilers rated 1,200,000 pounds per hour to No. 2 oil firing including burner and lighter equipment, burner management and controls, and auxiliary systems and equipment. Also included are fuel oil truck unloading facilities and two 81,000-barrel oil storage tanks. A study of the effect of cyclic operation on various equipment and systems was performed and recommended changes were included in conversion design.

Design of facilities for conversion of lighters and warmup guns from natural gas-fired to oil-fired at the Joliet Station, Joliet, Illinois. The conversion involves two 600 MW units; each of which is served by two pulverized coal-fired boilers. The project includes fuel delivery roadway, fuel oil unloading and storage facilities, atomizing air compressor, and the associated piping and electrical work.

Alma Generating Station; Alma, Wisconsin

Client: Dairyland Power Cooperative; LaCrosse, Wisconsin

This Installation: 370,000 kW cyclic duty

Fuel: Pulverized coal

Turbine: 1,800 psig/950 F throttle/950 F reheat

Coal Handling: Rail - unit train

Foundations: Long, high capacity, metal tube concrete-filled piling

Summit Lake Generating Station; Creston, Iowa

Client: Central Iowa Power Cooperative; Cedar Rapids, Iowa

This Extension: Two 30 MW

Type: Gas-turbine package power plant with unfired waste heat recovery boilers to repower existing steam turbines

Fuel: Diesel oil and natural gas

Union Carbide Corporation; New York, New York

Complete electrical and structural design of a 100 MW, 60 Hz industrial substation for power supply to electric furnaces at the Alloy, West Virginia, plant to operate in conjunction with a 25 Hz power supply.

Engineering services to convert the pulverizing systems on three steam generating units at the Alloy, West Virginia, plant. The work consisted of removal of the ball-type pulverizers and installation of new and larger roll type. Design was scheduled to permit execution of the work associated with one boiler in a 4-week shutdown period.

Analysis and report on the capacities and operating practices of the existing 25 Hz power system at Alloy, West Virginia.

Study and report on the method of minimizing the total cost of electric power for furnace operation at Alloy, West Virginia, with 60 Hz purchase power and 25 Hz generation.

Development of a computer program at Alloy, West Virginia, to permit operating personnel to optimize power costs under varying load conditions.

Wisconsin Electric Power Company; Milwaukee, Wisconsin

Engineering services for the new 345/138/26.4 kV Racine Substation. Services included complete design of control metering and relaying, site development, control house, heating, lighting, ventilation, bus layouts, outdoor lighting, grounding, structural steel and foundations; preparation of cost estimates, construction specifications, and complete bills of material and material lists for equipment purchases. Review of shop drawings was also performed for this Station.

Design of additions to the North Appleton 345 kV Substation including plans for site development, foundations, structural steel, grounding, bus layouts, and outdoor lighting. Site development specifications and detailed bills of material and material lists for equipment purchases were also prepared.

Complete engineering and architectural services for the new, aesthetically treated 138/13.8 kV Haymarket Square Substation located in an urban renewal area of downtown Milwaukee. Design services for this substation included plans for electrical, architectural, architectural landscaping, structural, transportation, building services, and preparation of cost estimates. Equipment and construction specifications were also prepared and shop drawings reviewed.

Engineering services for the new 138/26.4 kV Sugar Creek Substation. Services included complete design with plans for site development, structural steel and foundations, grounding, bus layouts, control metering and relaying, outdoor lighting, and control house including heating, ventilation, and lighting. Specifications were prepared for site development, structural steel, general construction, and complete bills of material and material lists were developed for equipment purchased. Review of shop drawings was also performed.

Engineering services to convert two 300 MW pressurized-fired steam generating units to balanced draft operation at the Oak Creek Power Plant. The work included two induced draft fans per unit with accompanying breeching changes and necessary control modifications. Provisions were made in the breeching alterations to accommodate additional electrostatic precipitator cells. Re-design of a steam-air heater on Unit No. 7 was also included.

Study to determine feasibility of the transfer of ownership of the city of Milwaukee's street lighting system to Wisconsin Electric Power Company. The study included an inventory and valuation of existing municipally owned street lighting facilities along with recommendations and estimate of construction costs for the modernization of the system. Cash flow tables and recommendations pertaining to ownership were included.

Design of additions to the St. Martins, Lincoln, Jefferson, Hayes, and Butler 138/26.4 kV Substations. Engineering design services with plans were prepared for all stations covering outdoor lighting, grounding, bus layouts, structural steel, and foundations. Detailed bills of material and material lists were developed for equipment purchased. Control metering and relaying was also designed for St. Martins, Hayes, and Butler Substations. Specifications for site development and structural steel were also prepared for Hayes Substation, and structural steel specifications were developed for Butler Substation.

Wisconsin Electric Power Company; Milwaukee, Wisconsin (continued)

Preliminary engineering, architectural, and landscape architectural services for the 138-13.2 kV Iroquois Substation at Glendale, Wisconsin. Design involved aesthetic and architectural considerations compatible and in scale with this station located in a high-value residential area including a rendering and illustrations to facilitate permission to construct from the local planning commission.

Conceptual design for the aesthetically pleasing Shorewood Substation site development to assist the utility in obtaining zoning approval. Design included the 138-13.8 kV stepdown substation; three transformers; and associated circuit breakers, switches, controls, and control building including oil storage facilities for the 138 kV lines.

Site development, architectural layout, and design of the 138-13.2 kV Silver Spring Substation located in the city of Glendale, Wisconsin. The work also included development of three plausible arrangements and selection of the best solution to the problem including considerable landscape architecture, preparation of a color rendering to assist in obtaining zoning approval from the city of Glendale, and cost estimates for the construction of the substation.

Site development and architectural design of the 68th Street bulk power substation. The work included development of three possible arrangements with selection of the best overall solution including renderings, cost estimates, and construction drawings. Station electrical engineering was performed by the client.

Clinton Corn Processing Company, A Division of Standard Brands Incorporated; Clinton, Iowa

Design for installation of a 7,500 kW double automatic extraction turbine-generator including condenser, circulating water system, piping, and electrical work.

Design of foundation for a relocated 3,500 kW turbine-generator and new turbine room building.

Design for the installation of a 9,375 kW single automatic extraction noncondensing turbine-generator including piping and electrical work.

Design of the foundation for a relocated 3,500 kW turbine-generator.

Design for the installation of a 300,000 lb/hr, 450 psi, cyclone-fired boiler, auxiliaries, and building addition.

Clinton Corn Processing Company, A Division of Standard Brands Incorporated;
Clinton, Iowa (continued)

Design for the installation of a 330,000 lb/hr, 450 psi, cyclone-fired boiler, auxiliaries, building addition, and 300 ton/hr coal handling system.

Design and installation of mechanical dust collectors to limit particulate emissions from boiler stacks of two existing steam generating units firing crushed coal in cyclone furnaces. Units are rated 275,000 and 330,000 lb/hr steam.

Design for the installation of a 235,000 lb/hr, 450 psi, package gas/oil-fired boiler, auxiliaries, and building addition.

Design for installation of a relocated 4,000 kW, single automatic extraction noncondensing turbine-generator including foundation modifications, piping, and electrical work.

Iowa-Illinois Gas and Electric Company; Davenport, Iowa

Study, preparation of design outline, and design services for the installation at the Moline Generating Station, Moline, Illinois, of two unfired waste heat recovery boilers using exhaust gases from an existing power block of four combustion turbines to power a new 40 MW steam turbine-generator. Engineering design services include removal of an existing 20 MW steam generator and associated equipment together with relocation and isolation of balance of plant cycles and all new auxiliary equipment for the unit addition.

Complete design, survey, and resident inspection services for the 3-terminal, 161 kV Kilpeck Landing Switching Station located south of Muscatine, Iowa. The design included supervisory and power line carrier system for control of the station.

Design services for upgrading bus capacity, relocating transmission feeders and substation transformers at "P" Substation, and substation extension to accommodate a new generator breaker bay including design outline, equipment and construction contracts, preparation of material lists and requisitions, and review of shop drawings.

Iowa Electric Light & Power Company; Cedar Rapids, Iowa

Studies at the Sixth Street Steam-Generating Station in Cedar Rapids, Iowa, to determine the most economical means of supplying increasing export steam loads including evaluation of the resulting by-product electric generation and station net electric capability. Three computer programs were prepared for this study to assure the development of comprehensive results.

Iowa Electric Light & Power Company; Cedar Rapids, Iowa (continued)

Complete design, survey, and resident inspection on approximately 40 miles of single-circuit, 34.5 kV transmission line and 3 miles of double-circuit, 34.5 kV transmission line. Both sections of line included underbuild.

Design of 16 miles of 115 kV transmission line.

Performance of structural investigation of several different types of steel towers in a section of 115 kV double-circuit transmission line to determine the feasibility of increasing the conductor size.

Complete design of Parnell Substation, a new 161-34.5 kV substation, with one 37 MVA transformer and two initial 34.5 kV feeders. Design work included equipment specifications, bus layouts, structure design, site development, grounding, lighting, foundation design, control panel layouts, schematics, and detail wiring diagrams. Complete bills of material and engineering requisitions for materials were prepared.

Engineering services including system analysis, planning, and developmental studies for a new system control center. Studies included identification of electric and gas systems; objectives and needs; analysis of functional considerations; and development of plans and alternates considering operations and operating economics, system security, instrumentation, hardware, man-machine communications, programming and software needs, control center siting factors, and presentation of selected plans together with priorities in the report.

Complete design and development of a 100 psi header system and two pressure reducing stations at Sixth Street Station in Cedar Rapids, Iowa, including structural and pipe stress analysis.

Design of a new water treatment plant at the Sixth Street Station including a 1,500 gpm demineralizer, two train, two bed exchanger.

Design services including preparation of plans and specifications for relocating transmission and distribution lines, preparation of inventory and evaluation of facilities removed in connection with Interstate 380 routing in Cedar Rapids.

Engineering services in connection with design and preparation of plans and specifications to relocate high and low pressure steam mains and overhead and underground transmission and distribution facilities within an urban renewal area and to accommodate Interstate 380 highway routing in downtown Cedar Rapids.

Iowa Electric Light & Power Company; Cedar Rapids, Iowa (continued)

Engineering services in connection with design of foundations for the 161-34.5 kV, 50 MVA transmission Vinton Substation, control house, cable trench, underground duct system, preparation of plans and specifications, and review of shop drawings for the associated construction contracts.

Iowa Electric Light & Power Company/Quaker Oats Company; Cedar Rapids, Iowa

Engineering studies and review of an existing furfural residue handling system of Quaker Oats Company and operations and firing of residue in power station boilers of Iowa Electric Light & Power Company. Studies included examination of conveying, storing, controlling, measuring, combustion, and safety in handling and firing, as well as air and water pollution abatement programs with existing equipment and examination of alternate furfural residue firing in added boiler facilities.

Grand Haven Power Plant; Grand Haven, Michigan

Client: Board of Light and Power; Grand Haven, Michigan

Total Plant Capacity: 24,000 kW

Latest Plant Addition: 7,000 kW

Fuel: Diesel oil and natural gas

Indianapolis Power & Light Company; Indianapolis, Indiana

Site development, architectural layout, and aesthetic treatment of the 138-13.8 kV Crestview Substation located in the city of Indianapolis, Indiana. The work included development of three alternative concepts for aesthetic treatment of the substation. Following selection of the best alternate, landscape architecture and preliminary engineering with appropriate cost estimates were provided for construction of the site including substation walls and gates. Three colored renderings were prepared to assist in obtaining zoning approval from the city of Indianapolis for construction of the substation at this site.

Site development, architectural layout, and aesthetic treatment of the 138-13.8 kV Parker Substation located in the city of Indianapolis, Indiana. The work included development of alternative concepts for aesthetic treatment of the substation. Following selection of the best alternate, landscape architecture and preliminary engineering with appropriate cost estimates were provided for construction of the site including substation walls and gates. Renderings were prepared for exhibits and assistance was provided to obtain zoning approval from the city of Indianapolis for construction of the substation at this site.

Citizens Utilities Company; Stamford, Connecticut

Investigations of operating problems, field tests and observations, and reports on performance of four 3,500 kW diesel generating units installed at the Mike Hart Generating Station near Kingman, Arizona.

Complete design, equipment procurement, and resident inspection services for the 230/69/12.5 kV Hilltop Substation at Kingman, Arizona. The substation is supplied by a tap from the United States Bureau of Reclamation's Davis Dam-Prescott 230 kV transmission line. The 230 kV substation is low profile design with power circuit breaker and by-pass switches and includes a 24/32/40 MVA LTC stepdown autotransformer (230-69 with a 12 kV tertiary winding).

Inspection and evaluation at the Valencia Diesel Generating Station, Nogales, Arizona, and recommendations including existing facilities, operation, maintenance, spare parts, and records.

A comprehensive study of a 14,000 kW gas engine plant covering operations, maintenance, personnel, organization, and recommended plant improvements.

Expansion of the existing Valencia Substation, Nogales, Arizona, by adding two 12/16/20 MVA transformers, 138 kV primary, 13.8 kV secondary, with rewiring of relays, control, and telemetry systems to accommodate secondary conversion from a 3-wire to a 4-wire system.

Perform a ten-year power supply study covering two noncontiguous counties in Arizona. The study involved approximately 250 miles of existing and planned transmission lines, 115, 138, and 230 kV, plus overlay onto USBR and Arizona Public Service Company systems including the performance of computer load studies, scheduling of power deliveries, long-range planning, cost estimates, and general reliability analysis.

Identify alternative transmission corridors and conduct environmental assessments for a 230 kV transmission line of 60 miles in western Arizona. Effects of changes in routing, structure types, and right-of-way treatment were evaluated. The Upper Sonoran Desert, site of the project, recovers slowly from any intrusions and requires careful consideration of construction, operational, and maintenance techniques.

GAC Properties Inc. of Arizona/Citizens Utilities Company - Rio Rico Project

Master planning for an electrical system for development planned for up to 53,000 land parcels.

Development of electrical and construction standards in conjunction with the utilities serving the area.

GAC Properties Inc. of Arizona/Citizens Utilities Company - Rio Rico Project
(continued)

Design of 138/13.8 kV Sonoita Substation located near Nogales, Arizona, with two 12/16/20 MVA transformers, feeder circuits, and regulators; express feeders; underground distribution in the initial development areas; reroute of old 44 kV transmission line to clear "industrial" area, rebuilt to 138 kV standards; general coordination of underground services; and miscellaneous services such as street lighting for an intersection area, service to mobile home park, etc.

Hayden Station; Hayden, Colorado

Client: Colorado-Ute Electric Association, Inc.; Montrose, Colorado

Ultimate Capacity: 600 MW

Initial Installation: 173,000 kW

Fuel: Pulverized coal, pressurized-fired

Turbine: 1,800 psig/1,000 F throttle/1,000 F reheat

Condenser Cooling: Cooling tower system

Structural Foundations: Concrete caissons

East Kentucky Power Cooperative; Winchester, Kentucky

Engineering services including analysis of requirements to provide system load data and establish the cooperative as a separate load control area. Design services for purchase and installation of supervisory and data acquisition equipment for seven substations, computer-based data acquisition from 29 substations, and automatic generation control of four generators including computer interface to an existing dispatch center.

Central Illinois Light Company; Peoria, Illinois

Complete design of the East Peoria, Northmoor, Park, Allen, Metamora, and Sand Prairie 69-13.2 kV distribution substations including equipment specifications, bus layouts, structure design with steel fabrication detail drawings, site development, grounding, lighting, foundation design with rebar detailing, control panel layouts, schematics, and detail wiring diagrams. Complete bills of material and engineering requisitions for the materials were prepared.

East Peoria, Northmoor, and Park Substations consist of 13.2 kV outdoor metal-clad switchgear and a 69 kV bus arrangement designed for future expansion to a ring bus. Northmoor Substation is fed by an underground 69 kV solid-dielectric cable circuit.

Central Illinois Light Company; Peoria, Illinois (continued)

Allen, Metamora, and Sand Prairie Substations were designed around the use of a 13.2 kV main and transfer bus, high and low voltage, low profile structures. The structures were developed for either underground or overhead 13.2 kV feeders.

Republic of Bolivia - Phases I and II Rural Electrification Projects

Design and construction supervision of rural electrification projects in five of the nine Departments (states) in the Republic of Bolivia. The Phase I project involves 1,100 kilometers of 14.4/24.9 kV distribution line, 100 kilometers of 10 kV distribution line, 1,200 kilometers of 220/380-volt secondary, 25,000 service installations, six new or expanded existing substations, and a new office building. The Phase II project is approximately one-half as large as Phase I. The geophysical characteristics of the project zones range from low, subtropical, to high mountainous (elevation in excess of 4,000 meters). Design and construction supervision are being performed in conjunction with Bolivian and Argentine engineering firms.

Fair Station; Montpelier, Iowa

Client: Eastern Iowa Light and Power Cooperative; Wilton, Iowa

Ultimate Capacity: 250 MW

Initial Installation: 22,000 kW

Fuel: Pulverized coal

Turbine: 850 psig/900 F

Coal Handling: River barge, rail, or truck

Foundations: Pileings and pumped fill

Plant Addition: 33,000 kW

Fuel: Pulverized coal

Turbine: 850 psig/900 F

Coal Handling: River barge, rail, or truck

Foundations: Piling

Iowa Public Service Company; Sioux City, Iowa

Design services for the 161-69/34.5 kV, 25/33.3/41.6 MVA Monona Substation with two high voltage and four initial low voltage transmission feeders including design outline, equipment and construction contracts, preparation of material lists and requisitions, review of shop drawings, and construction management services.

Design services for the 161-12.47 kV, 20/27/33 MVA Interchange Substation with two high voltage terminals and low voltage metal-clad switchgear with five distribution feeders including design outline, equipment and construction contracts, preparation of material lists and requisitions, review of shop drawings, and construction management services.

Design services for the 69-12.47 kV, 15/20/25 MVA Hampton West Substation with three high voltage terminals and low voltage metal-clad switchgear with four distribution feeders including design outline, equipment and construction contracts, preparation of material lists and requisitions, and review of shop drawings.

Design services for the 161-12.47 kV, 20/27/33 MVA Leeds Substation with two high voltage terminals and low voltage metal-clad switchgear with six distribution feeders including design outline, equipment and construction contracts, preparation of material lists and requisitions, and review of shop drawings.

National Electrification Administration; Philippines

Management and technical advisory services to National Electrification Administration for a \$100 million (U.S.) rural electrification program establishing more than 50 rural electric cooperatives throughout the Philippines to provide electric service to 2.5 million people. A team of five electrical engineering advisers and a materials procurement/warehousing adviser was provided for several years in the Philippines to establish systems standards, advise and train in all related engineering matters including feasibility analyses, long-range planning, right-of-way methods, design and specifications, construction, and worldwide procurement of equipment and materials.

Environmental Assessment and Impact Analysis

Stanley Consultants performs the following types of environmental analysis and design work:

Description and assessment of natural resources.

Environmental Assessment and Impact Analysis (continued)

Prediction of the consequences of project alternatives upon resources, upon environmental conditions, and upon development opportunities.

Fulfillment of the National Environmental Policy Act requirements for submission of environmental impact analysis.

Typical projects involving environmental assessment and/or impact analysis which have been performed are:

East Kentucky Power Cooperative, Kentucky

Proposed action: Construction of the 850 MW (two units), coal-fired electric Spurlock Generating Station on the Ohio River.

Proposed action: Construction of a single-circuit, 345 kV transmission line approximately 58 miles in length from Spurlock Generating Station to the new Avon 345/138 kV Substation.

Central Iowa Power Cooperative, Iowa

Proposed action: Installation of two gas/oil-fired turbine-generators with waste heat recovery boilers to provide additional capacity and eliminate emissions from existing coal/gas-fired boilers.

Southern Illinois Power Cooperative, Illinois

Proposed action: Installation of three electrostatic precipitators for control of particulate emissions.

Corn Belt Power Cooperative, Iowa

Proposed action: Installation of two electrostatic precipitators for control of particulate emissions at two stations.

Eastern Iowa Light and Power Cooperative, Iowa

Proposed action: Installation of two electrostatic precipitators for control of particulate emissions.

Alabama Electric Cooperative, Alabama

Proposed action: Installation of two electrostatic precipitators for control of particulate emissions at two stations, stoker- and pulverizer-fired.

Environmental Assessment and Impact Analysis (continued)

Golden Valley Electric Association, Alaska

Proposed action: Installation of one electrostatic precipitator for control of particulate emissions.

Menasha Electric and Water Utilities, Wisconsin

Proposed action: Installation of one electrostatic precipitator for control of particulate emissions.

The Cleveland Electric Illuminating Company, Ohio

Proposed action: Installation of 345 kV transmission lines and railroad spur associated with proposed nuclear plant (certain sections of this work were in association with NUS Corporation).

Ohio Edison Company, Ohio

Proposed action: Installation of 48 miles of 138 kV, single-circuit transmission line.

U.S. Army Corps of Engineers, St. Louis District, Missouri

Proposed action: Development plan for the environmental enhancement of Cannon Dam including the spillway, powerhouse, and a two-mile downstream corridor.

Forest City, Iowa

Client: City of Forest City, Iowa

Total Installed Capacity: 14,525 kW

No. of Units Installed: 9

Largest Unit: 6,325 kW

Fuel: Diesel oil and natural gas

Union Electric Company; St. Louis, Missouri

Structural and hydrological review of earth and rock slide areas along the west bank of the Mississippi River adjacent to the Keokuk Hydroelectric Power Plant, examination of steel transmission tower foundations adjacent to the plant forebay, and recommendations to control surface and ground water flows in the slide areas.

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Earl F. Wisdom Station; Spencer, Iowa

Client: Corn Belt Power Cooperative; Humboldt, Iowa

Ultimate Capacity: 350 MW

Initial Installation: 33,000 kW

Fuel: Pulverized coal and natural gas

Turbine: 850 psig/900 F

Condenser Cooling: Cooling tower system

Foundations: All structures supported on soil compacted by
vibro flotation process

Humboldt Station; Humboldt, Iowa

Client: Corn Belt Power Cooperative; Humboldt, Iowa

Total Installed Capacity: 41,500 kW

No. of Units: 4

Largest Unit: 15,000 kW, 850 psig/900 F

Fuel: Pulverized coal and gas

Condenser Cooling: Des Moines River water circulating system

Corn Belt Power Cooperative - Various Diesel Plants in Iowa

Client: Corn Belt Power Cooperative; Humboldt, Iowa

Total Installed Capacity: 26,000 kW

No. of Units Installed: 23

Largest Unit: 1,600 kW

Fuel: Diesel oil

Corn Belt Power Cooperative; Humboldt, Iowa

Engineering services including system analysis of present and future operational requirements of the Corn Belt Power Cooperative control center. Studies included alternate plans for supervisory control and data acquisition, generation dispatch, and location of the system control center.

Design services for a system control center and remote terminals including a dual computer configuration directing functions of supervisory control, data acquisition, and automatic generation control.

Machu Picchu Power Plant; Cuzco, Peru

Client: Corporación de Reconstrucción y Fomento del Cuzco

Total Installed Capacity: 40,000 kW

No. of Units Installed: 2

Services Performed: Investigation and analysis of damage to Francis Turbines, recommendation of corrective action, and assistance in preparation of testimony for litigation involving the design and selection of equipment.

Interstate Power Company; Dubuque, Iowa

Engineering studies to examine export steam supply alternatives including use of existing or added facilities, environmental restraints, and cost estimates to deliver process steam from an existing power plant to an industry.

Erickson Generating Station; Lansing, Michigan

Client: Board of Water and Light; Lansing, Michigan

Ultimate Capacity: 1,500 MW

Initial Installation: 160,000 kW

Fuel: Pulverized coal

Turbine: 1,800 psig/1,000 F throttle/1,000 F reheat

Condenser Cooling: Cooling tower system

Coal Handling: Initial - volume train
Future - unit train

French Meadows, Middle Fork, Oxbow, and Ralston Stations; Middle Fork American River Project, California

Client: Ets-Hokin Corporation; San Francisco, California

Initial Installation: 225,000 kW (5 units)

	<u>Turbines</u>	<u>Generators</u>
French Meadows	Francis Type (rated 24,000 HP)	17,000 kVA
Middle Fork	Impulse Type (2 units rated 82,000 HP each)	61,000 kVA each

French Meadows, Middle Fork, Oxbow, and Ralston Stations; Middle Fork American River Project, California (continued)

	<u>Turbines</u>	<u>Generators</u>
Oxbow	Francis Type (rated 8,800 HP)	7,300 kVA
Ralston	Impulse Type (rated 106,000 HP)	88,000 kVA

Southern Indiana Gas and Electric Company; Evansville, Indiana

Engineering design of approximately nine miles of 138 kV transmission line from the Evansville Northwest Substation to a point of connection with Big Rivers RECC at the Ohio River.

Hiram Walker - Gooderham & Worts, Ltd.; Ontario, Canada

Design of power plant at Peoria, Illinois, to generate steam in a boiler which burns wood waste from a cooperage. Special problems were encountered in handling and blending three different sizes of wood waste to produce proper combustion conditions.

Gibson Hydraulic Turbine Performance Testing

Tests: Over 35 units in the United States, Canada, Central America, Europe, and West Africa

Measured Discharge Quantities, cfs: 5 - 14,300

Effective Heads, ft: 60 - 2,600

United States Navy, Naval Facilities Engineering Command

Adak (Aleutian Islands), Alaska Generation - Plant 3
Five separate expansions, 15,000 kW diesel

Adak Generation - Plant 5
Modifications to plant switchgear and electrical system

Adak Communications - Design for two emergency generator installations; power systems/telephone interference investigations

Adak Distribution - Comprehensive system study, construction manual, relay studies and settings, and extensive electric distribution system rehabilitation and extensions covering entire Island

United States Navy, Naval Facilities Engineering Command (continued)

McMurdo, Antarctica - Power plant expansion, 1,000 kW diesel

Subic Bay, Philippine Republic

 Addition to main power plant, 4,400 kW diesel

Oahu, Hawaii - Development of emergency and casualty correction plans for vital communications power supplies

Pearl Harbor, Hawaii - Studies and tests to reduce fuel consumption at steam power plants, Pearl Harbor and Guam

Rota, Spain - Rehabilitation of sea water supply facilities for steam plant condenser cooling water

Asmara, Ethiopia - Management services and rehabilitation, Gura Diesel Power Plant

New London, Connecticut - Consultation and construction drawings for diesel power supply to underwater acoustical laboratory (Project AFAR) at the Azores

Great Lakes, Illinois - Study and tests to consolidate all boiler controls into central control room

Great Lakes, Illinois - Study and tests to reduce steam plant fuel consumption

Great Lakes, Illinois - Comprehensive study of steam and condensate systems originating in main power plant

Great Lakes, Illinois - Update for the plant training manuals

Norfolk, Virginia, Naval Shipyard - Pilot test program for fuel conservation and studies for steam plant expansion

Norfolk, Virginia, Public Works Center - Study and tests to reduce fuel consumption

Seventeen boiler performance tests in Washington, D.C., Naval District

Preparation of standard diesel power plant designs and type specifications

Preparation of standard manual, "Operations and Maintenance of Internal Combustion Engines"

United States Navy, Naval Facilities Engineering Command (continued)

Preparation and conducting of training programs for "Heating and Power Plant Operators"

Management studies and reports - MUSE and DOD-PM-MEP

Numerous "trouble-shooting" operational studies for various diesel power plants

Preparation of new standard diesel power plant designs and type specifications

U.S. Army, Corps of Engineers

Minot Air Force Base - High temperature hot water system including lignite-fired plant

Rapid City Air Force Base - Study on central heating plant and distribution system

Grand Forks Air Force Base - All utilities including lignite-fired high temperature water heating plant and six miles of distribution

Malstrom MSR Facility for Safeguard Program - Site adaption of six units, 16,500 kW underground diesel power plant and substation

Clarence Cannon Dam, Missouri - Environmental enhancement and architectural treatment including dam, spillway, powerhouse, and two-mile downstream corridor

Iowa Power and Light Company; Des Moines, Iowa

Engineering services for the 161-69 kV transmission Hastings Substation including design outline, plans and specifications for site development, all structures, control house, construction contracts, preparation of material lists and requisitions, and review of shop drawings.

Tombigbee Plant; Jackson, Alabama

Client: Alabama Electric Cooperative, Inc.; Andalusia, Alabama

Ultimate Capacity: 500 MW

Initial Installation: 75,000 kW

Fuel: Pulverized coal

Turbine: 1,250 psig/950 F

Structural Foundation: 100 ft. piling, 15 ft. of hydraulic fill

T. J. R. Faulkner & Walter F. Walker Station; Mt. Coffee, Liberia, West Africa

Client: Republic of Liberia

Ultimate Capacity: 90,000 kW

Initial Installation: 30,000 kW (2 units)

Turbines: Francis Type (rated 21,000 HP)

Generators: 17,650 kVA (normal rating)

Main Dam: Length - 1,840 ft.

Height - 70 ft.

Spillway Design Flood: 350,000 cfs

Ohio Edison Company; Akron, Ohio

Technical and environmental analyses of alternate routes for a 138 kV, single-circuit transmission line and preparation of Certificate of Environmental Compatibility and Public Need as required by the Ohio Power Siting Commission. The site report covers a 48-mile preferred route and a 46-mile alternate route for the Star-West Akron line section.

Government of Antigua; St. John's, Antigua, West Indies

Studies, assistance in obtaining financing, design, procurement, and construction supervision of Crabbs Peninsula Power Plant and water supply system involving relocation of existing steam and diesel generation, new 8,200 kW diesel equipment with heat recovery, and a 1.2 MGD desalination plant to augment limited Island water supply utilizing all available waste heat and automatically utilizing supplemental live steam in response to water requirements.

Investigate operational failure of two existing 3,000 kW steam turbine generating units at Friars Hill and arrange emergency power for Antigua. Recommend a new plant site to which existing usable equipment could be moved to become part of a new generating system. Design a new layout for a steam generating system making maximum utilization of existing components to become part of the total power system. Supervise plant relocation and construction on the new site. Assist in obtaining financing.

Provide management services for the electric power, telephone, and water systems for the Island of Antigua. Initial services covered recommendations and procedures for the formation of a Public Utilities Authority as a government-owned corporation to provide electric power supply, transmission, and distribution services for the entire Island. Further services included providing a utility management team on the Island to manage the implementation of the recommended transition procedures to the new organization, to direct the training programs, and to counsel and advise the Authority, as required, in the fiscal management of the utility.

The Hubinger Company; Keokuk, Iowa

Report on steam and electric supply for a corn processing plant with recommendations for improving the steam supply and for generating plant electric facilities.

Design and supervision of construction for installation of a 185,000 lb/hr, 400 psi, 750 F boiler, together with auxiliaries.

Design for the installation in a new plant of a 125,000 lb/hr, 450 psig, 750 F, gas/oil-fired boiler and auxiliaries, together with a fuel oil tank farm. The boiler will initially operate at 235 psi saturated conditions.

Study and report to include two high-efficiency mechanical collectors and a new stack for sulfur dioxide dispersion for two spreader stoker-fired steam generating units.

Orenda, Inc.; Chicago, Illinois

Complete heat cycle analysis including alternate waste heat recovery methods for a standard production gas turbine with a full range of uses for waste heat recovery. The work included development of a completely computerized program with print-out.

The Cleveland Electric Illuminating Company; Cleveland, Ohio

Environmental analysis and corridor studies of alternative routes for two 345 kV, double-circuit transmission lines approximately 93 miles in length through a 20 x 50 mile study area in northeast Ohio. Analysis included the expected impact of alternative structure design and line locations on natural and cultural resources and on anticipated community development patterns. Recommendations were made for optimum routing, line configuration, structure type, and right-of-way treatment. Underground transmission was considered as one of the alternates. This work was with NUS Corporation for the Environmental Report submission to the Atomic Energy Commission in connection with the proposed Perry Nuclear Power Plant.

Complete structural design of the structures and foundations for the 132-33 kV Grovewood Substation located at Cleveland, Ohio. The design included preparation of complete fabrication details for the steel and aluminum structures for this station initially utilizing two 90 MVA transformers.

Double-circuit, 345 kV transmission line environmental routing and preparation of the Application for a Certificate of Environmental Compatibility and Public Need as required by the Ohio Power Siting Commission. The site report covered 53 miles of preferred route and 56 miles of alternate route for the Perry-Macedonia-Inland line sections.

The Cleveland Electric Illuminating Company; Cleveland, Ohio (continued)

Double-circuit, 345 kV transmission line environmental routing and preparation of the Application for a Certificate of Environmental Compatibility and Public Need as required by the Ohio Power Siting Commission. The site report covered two miles of preferred route and approximately three miles of alternate route for the Inland-Harding line section.

Investigations concerning construction of a nuclear generating plant in north-eastern Ohio. Social and economic impacts of construction work forces on community structure, schools, and housing resources were evaluated.

Bushrod Island Power Plant; Monrovia, Liberia, West Africa

Client: Republic of Liberia

Total Plant Capacity: 13,000 kW

Initial Installation: 5,500 kW
Largest Unit: 2,000 kW

Plant Addition: 7,500 kW
Largest Unit: 2,500 kW
Fuel: Diesel oil

Boulevard Shopping Center; Las Vegas, Nevada

Study, design, and initial equipment selection for a completely underground utility center to supply electricity, cooling, heating, water, and compressed air to a shopping center complex. Natural gas engines, full waste heat recovery, absorption, and centrifugal chillers were included.

Portland Generating Station; De Funiak Springs, Florida

Owner: Choctawhatchee Electric Cooperative, Inc.; De Funiak Springs, Florida

Client: Alabama Electric Cooperative, Inc.; Andalusia, Alabama

Initial Installation: 11.5 MW

Type: Gas-turbine package power plant
Fuel: Diesel oil

Municipal Electric Plant; Muscatine, Iowa

Client: Muscatine Power and Water; Muscatine, Iowa

Plant Capacity: 129,000 kW

Latest Extension: 83,500 kW

Fuel: Coal (cyclone furnace) and natural gas

Turbine: 1,250 psig/950 F

Condenser Cooling: Supplied from Mississippi River

Structural: All structures founded on piling driven into sand and gravel

Ohio Power Company; Canton, Ohio

Engineering studies and analysis for the development of streets and roadways, storm drainage, water supply and distribution, and sanitary sewerage systems for a proposed new town development at Wilkshire, Ohio.

Liberia Mining Company; Bomi Hills, Liberia, West Africa

Design and supervision of a three-unit addition to the diesel electric generating plant including switching, transformation, and transmission system work from the powerhouse to outlying iron ore mine buildings and equipment.

University of Utah; Salt Lake City, Utah

Report on extension of campus buildings central heating system, economic comparisons of high temperature water and steam heating plans and systems, and recommended plan for future development. This was followed by design of a high temperature water heating system including two boilers totaling 120,000,000 Btu/hr.

Healy Plant; Healy, Alaska

Client: Golden Valley Electric Association, Inc.; Fairbanks, Alaska

Ultimate Capacity: 266 MW

Initial Installation: 22,000 kW

Fuel: Pulverized coal

Turbine: 850 psig/900 F

Coal Handling: Truck from nearby mine

Foundations: Spread footings

Nebraska City Power Plants 1 and 2; Nebraska City, Nebraska

Client: Nebraska City Utilities; Nebraska City, Nebraska

Total Plant Capacity: 19,650 kW

Plant No. 1 Addition: 6,415 kW

Fuel: Diesel oil and natural gas

Air Quality Control

East Kentucky Power Cooperative - Spurlock Generating Station - 530 MW unit. Design a four-unit, hot side electrostatic precipitator, stacked two to a side, with 99.5% collection efficiency.

East Kentucky Power Cooperative - Spurlock Generating Station - 320 MW unit. Design a two-unit, hot side electrostatic precipitator, chevron arrangement, with 99.5% collection efficiency.

East Kentucky Power Cooperative - Cooper Station - 354 MW (2 units). Design two electrostatic precipitators with 99% collection efficiency.

East Kentucky Power Cooperative - Dale Station - 194 MW (4 units). Design two electrostatic precipitators for Units 3 and 4 (148 MW). The overall collection efficiency of the station is 99%.

Dairyland Power Cooperative - Alma Station - 370 MW unit. Design a four-unit, hot side electrostatic precipitator, stacked two to a side, with 99.6% collection efficiency.

Union Carbide Corporation - Alloy, West Virginia, Power Station. Design four electrostatic precipitators with 99.3% collection efficiency.

Union Carbide Corporation - Marietta, Ohio, Power Station. Design four electrostatic precipitators with 98% collection efficiency.

Lansing, Michigan - Erickson Station - 160 MW unit. Design electrostatic precipitator with 99% collection efficiency.

Colorado-Ute Electric Association - Hayden Station - 173 MW unit. Design electrostatic precipitator with 98.5% overall collection efficiency.

Alabama Electric Cooperative - Tombigbee Station - 75 MW unit. Design hot side electrostatic precipitator, rigid electrodes, with 99.3% overall collection efficiency.

Air Quality Control (continued)

Alabama Electric Cooperative - McWilliams Station - 25 MW unit. Design hot side electrostatic precipitator, rigid electrodes, with 99.3% overall collection efficiency.

Corn Belt Power Cooperative - Wisdom Station - 33 MW unit. Design electrostatic precipitator with 99% overall efficiency.

Corn Belt Power Cooperative - Humboldt Station - 15 MW unit. Design electrostatic precipitator with 99% overall efficiency.

Eastern Iowa Light and Power Cooperative - Fair Station - 55 MW (2 units). Design two roof-mounted electrostatic precipitators with 99% overall collection efficiency.

Southern Illinois Power Cooperative - Marion Plant - 100 MW (3 units). Design three electrostatic precipitators with 96% overall collection efficiency.

Muscatine, Iowa - Municipal Power Plant - 83.5 MW unit. Design electrostatic precipitator with 95.2% collection efficiency.

45 MW (3 units). Design electrostatic precipitator and two high-efficiency mechanical dust collectors with overall collection efficiency of 92%.

Clinton Corn Products Company - Clinton, Iowa, Power Station. Design two electrostatic precipitators with 95% overall collection efficiency.

Northern Michigan Electric Cooperative, Inc. - Advance Station - 37 MW (3 units). Design two electrostatic precipitators with 98% overall collection efficiency.

Menasha, Wisconsin - Municipal Power Plant - 30 MW (4 units). Design dual-chamber electrostatic precipitator with 90% overall collection efficiency.

University of Iowa - Iowa City Campus Power Plant. Design electrostatic precipitator with 99% overall collection efficiency.

National Starch and Chemical Corporation - Indianapolis, Indiana, Power Plant. Design roof-mounted, 95% efficient electrostatic precipitator and three high-efficiency mechanical dust collectors.

Advance Station; Advance, Michigan

Client: Northern Michigan Electric Cooperative, Inc.; Boyne City, Michigan

Ultimate Capacity: 70 MW

Latest Extension: 22,000 kW

Fuel: Pulverized coal

Turbine: 850 psig/900 F

Coal Handling: Lake coal carrier

Foundations: Piling

St. Joseph Light and Power Company; St. Joseph, Missouri

Engineering design of a six-mile, 161 kV, single-pole line and a 10 MVA industrial substation located in northwestern Missouri.

Pearl Station; Pearl, Illinois

Client: Western Illinois Power Cooperative, Inc.; Jacksonville, Illinois

Initial Installation: 22,000 kW

Fuel: Pulverized coal

Turbine: 850 psig/900 F

Coal Handling: River barge, rail, or truck

Foundations: Piling on fill

Owatonna, Minnesota

Client: Municipal Public Utilities Commission; Owatonna, Minnesota

Total Installed Capacity: 39,925 kW

No. of Units: 6

Largest Unit: 21,800 kW, 850 psig/900 F

Fuel: Natural gas and oil

Condenser Cooling: Cooling tower

State of Wisconsin - State Colleges

Central Heating Plant, Menomonie campus

Central Heating Plant, Platteville campus

Central Heating/Chilling Plant, Parkside campus

Hill Farm State Office Building central plant

127526

South River Station; Palmyra, Missouri

Client: Northeast Missouri Electric Power Cooperative; Palmyra, Missouri

Initial Installation (Steam): 15,000 kW

Fuel: Coal

Turbine: 600 psig/825 F

Total Installed Capacity (Diesel): 7,500 kW

No. of Units Installed: 3

Largest Unit: 2,500 kW

Fuel: Diesel oil

A Combine Consisting of Walsh-''Mothercat''-Commonwealth-Foley; Lagos, Nigeria

Preliminary designs for approximately 320 miles of 345 kV (European 330 kV) and 65 miles of 138 kV (European 132 kV) transmission line in Nigeria, West Africa.

Colorado-Ute Electric Association, Inc.; Montrose, Colorado

69, 115, 138, and 230 kV transmission lines

Substations: High voltage through 138 kV

Switching stations

Golden Valley Electric Association, Inc.; Fairbanks, Alaska

69 and 138 kV transmission lines

River crossing: 138 kV transmission line, 145-foot towers, 1,700-foot span

Substations: Stepdown 138/69 kV and 138/24.9 kV

Length of 138 kV line: 100 miles on guyed "Y" aluminum towers, permafrost area

East Kentucky Power Cooperative; Winchester, Kentucky

69, 138, 161, and 345 kV transmission lines

Substations: High voltage through 345 kV

Switching stations

Corn Belt Power Cooperative; Humboldt, Iowa

69, 115, and 161 kV transmission lines

Substations: High voltage through 161 kV

Switching stations

Alabama Electric Cooperative, Inc., Andalusia, Alabama

115 kV transmission lines

River crossing: 115 kV transmission line, 150-foot towers, 1,250-foot span

Big Rivers RECC; Henderson, Kentucky

138 kV transmission lines

River crossing: 161 kV transmission line, 175-foot towers, 2,300-foot span

Northeast Missouri Electric Power Cooperative; Palmyra, Missouri

69 and 161 kV transmission lines

Substations: High voltage through 345 kV

Arizona Electric Power Cooperative, Inc.; Benson, Arizona

115 kV transmission lines

Substations: 115 kV

Muscatine Power and Water; Muscatine, Iowa

69 and 161 kV transmission lines

Substations: High voltage through 161 kV

Basin Electric Power Cooperative; Bismarck, North Dakota

230 kV transmission lines

Substations: 230/115 kV

Crawfordsville Electric Light and Power Company; Crawfordsville, Indiana

138 kV transmission lines

Substation: 138 kV

East River Electric Power Cooperative, Inc.; Madison, South Dakota

230 kV transmission lines

Substations: High voltage through 230 kV

Spencer Municipal Electric Plant; Spencer, Iowa

Client: City of Spencer, Iowa

Ultimate Capacity: 50 MW

This Extension: 7,500 kW

Fuel: Coal (spreader stoker) and natural gas

Turbine: 650 psig/825 F

Condenser Cooling: Cooling tower system

Summit Lake Plant; Creston, Iowa

Client: Southwestern Federated Power Cooperative, Inc.; Creston, Iowa
(Now: Central Iowa Power Cooperative)

Total Installed Capacity (Steam): 22,500 kW

No. of Units Installed: 3

Largest Unit: 7,500 kW, 600 psig/825 F

Fuel: Coal

Condenser Cooling: Cooling tower

Total Installed Capacity (Diesel): 5,800 kW

No. of Units Installed: 5

Largest Unit: 1,200 kW

Fuel: Diesel oil

Poplar Bluff, Missouri

Client: M & A Electric Power Cooperative; Poplar Bluff, Missouri

Total Installed Capacity: 9,320 kW

No. of Units Installed: 4

Largest Unit: 2,330 kW

Fuel: Diesel oil

Planning and Area-Related Projects

The following is a partial listing of planning and area-related projects presently underway or completed by Stanley Consultants and its affiliates:

Regional Planning

ADAMS COUNTY REGIONAL PLANNING COMMISSION AND THE CITY OF CORNING, IOWA

Preparation of a comprehensive plan for the first regional agency established in Iowa. Work included development of base maps; background studies covering economic base, population, land use, transportation, utilities, schools, recreational facilities, housing, and central business district analysis; the development of a comprehensive plan for land use, community facilities, transportation, and improvements to the central business district of Corning, Iowa. Implementation programs included zoning, subdivision regulations, capital improvements program, and planning administration.

JO DAVIESS COUNTY, ILLINOIS

This county, located in northwest Illinois, lies adjacent to the Iowa and Wisconsin state lines, providing both development problems and opportunities. Studies encompass 23 rural townships and 7 incorporated communities. The coordinated comprehensive development plan for the 7 communities and county was 701 financed, and includes a water and sewer study financed by the Farmers Home Administration. The third year of this program included development of zoning regulations covering the municipalities and townships. Thirty public hearings were conducted by our staff.

RATHBUN REGIONAL PLANNING COMMISSION, IOWA

A project-oriented development program for four southern Iowa counties. This is the first Rural Renewal technical assistance planning project funded in Iowa by the Farmers Home Administration. Details of the planning program encompass future land and facility development around an 11,000-acre Federal reservoir completed in 1968. Over \$25 million have already been spent on this major impoundment. Regional impact was assessed and directed.

MARK TWAIN REGIONAL PLANNING COMMISSION, MISSOURI

The program was developed for an eight-county region in eastern Missouri adjacent to the Mississippi River. A 50-member commission designated by the Governor's office provided the public planning function. Work included preparation of individual county plans and



MARK TWAIN REGIONAL PLANNING COMMISSION, MISSOURI (Continued)

ordinances for five of the eight counties. The base project was under the auspices of Section 701 of the Federal Housing Act; water and sewer study aspects were financed by the Farmers Home Administration.

ZAMBIA, EAST AFRICA

Stanley Consultants provided a five-man team to undertake the collection and analysis of data required for the preparation of the second national development plan. The team operated in the Northern and Luapula Provinces comprising approximately one-third of the entire country. Data collection covered the infrastructure of agriculture, transportation, social services, banking and government facilities.

LOUISA COUNTY, IOWA

A special planning program was designed to utilize limited county resources and meet State and Federal program requirements for funding of future improvements. The comprehensive plan for this county of 10,000 persons will provide guidelines for county officials, and assist in meeting requirements of the State Conservation Commission and the Land and Water Conservation Act.

WHITESIDE COUNTY REGIONAL PLANNING COMMISSION, ILLINOIS

Preparation of comprehensive planning program for a county in western Illinois with a population of 60,000. The project received financial assistance from the Department of Housing and Urban Development. The program includes water and sewer study elements for the incorporated communities. Current activities include revision of the zoning ordinance and continuing assistance to seven municipal governments.

CARROLL COUNTY REGIONAL PLANNING COMMISSION, IOWA

Project includes organization of commission with preparation and adoption of Articles of Agreement and Bylaws. The countywide comprehensive planning program provides for the preparation of individual sketch plans and zoning provisions for 11 incorporated municipalities. Program emphasis is placed on development of coordinated county-community plans under cooperative planning administration.

HARRISON REGIONAL PLANNING COMMISSION, OHIO

Comprehensive planning program for county located in eastern Ohio. The commission, composed of representatives from all incorporated villages and the county, directed planning project which contained major study investigation and analysis of mineral resource deposits. Park-recreation planning study elements received program emphasis in the preparation of county development guidelines.

HARRISON COUNTY REGIONAL PLANNING COMMISSION, IOWA

Countywide comprehensive planning program, including the establishment of planning assistance to incorporated municipalities. This agriculturally oriented county, with a total population of 17,600, lies adjacent to the Missouri River on the Iowa-Nebraska state line.

WALSH COUNTY PLANNING COMMISSION, NORTH DAKOTA

Coordinated communities and rural area under one comprehensive planning program. Project included the preparation of plans to guide orderly economic and physical development of 12 incorporated communities. Unified standards for land development control were established for this county of 1,286 square miles.

RINGGOLD COUNTY REGIONAL PLANNING COMMISSION, IOWA

A unified, long-range plan was developed for ten communities and unincorporated area of this rural county in southern Iowa. The plan was supported by the preparation of land use regulations, capital improvements program, and administrative guidelines. Emphasis was placed on utilizing limited financial and human resources to achieve future goals.

RICHLAND COUNTY PLANNING COMMISSION, NORTH DAKOTA

Preparation of a comprehensive plan encompassing rural areas and incorporated communities to aid county and municipal officials in directing coordinated capital expenditures. The planning program includes analysis of socioeconomic factors, transportation framework, and full range of public facilities. Development of land use and resource plan with required development standards and controls will direct growth pattern.

STEELE-TRAILL JOINT PLANNING COMMISSION, NORTH DAKOTA

Comprehensive development plan for first multi-county regional planning program in North Dakota. Two county governments and 12 incorporated communities are cooperating to provide maximum local program participation and decision making. The program is directed to meet Department of Housing and Urban Development (DHUD) and Environmental Protection Agency (EPA) requirements for unified planning. Twenty-year projections are prepared for land use, transportation, economics, population, and major public facilities. Functional planning and programming elements cover water/sewer and open space. Major emphasis is directed to establishing a viable economic development strategy which should enhance growth potentials for this river-oriented region.

SHELBY COUNTY REGIONAL PLANNING COMMISSION, IOWA

A comprehensive planning program for the county, including assistance to all municipalities. Study included analysis, plans, and programs for the region of 15,500 persons in western Iowa. A solid waste management program was developed as part of the study.

FOUNTAIN COUNTY AREA PLANNING COMMISSION, INDIANA

Development of a long-range comprehensive plan for this rural county in western Indiana. Plans are being developed for eight incorporated communities and the unincorporated portion of this county of 18,300 persons. Land use controls and a unified capital improvements program were prepared to implement long-range plans.

WHITE COUNTY AREA PLANNING COMMISSION, INDIANA

Preparation of a comprehensive development plan for seven communities and the unincorporated portion of the county. All aspects of development were analyzed, and plans prepared for land use, transportation, community facilities, and utilities. Special attention was placed on planning around two recreation lakes in the central portion of the county. A housing program, as well as short-range capital improvements program, was prepared. Land use controls were formulated for all areas of the county.

KOSSUTH COUNTY REGIONAL PLANNING COMMISSION, IOWA

Analysis of population, employment, land use, transportation, housing, utilities, and community facilities for nine communities and the unincorporated area of the county of 23,000 in northern Iowa. Later phases of the program will include comprehensive plan development, preparation of land use regulations, capital improvements programming, and administrative guidelines.

UNION COUNTY REGIONAL PLANNING COMMISSION, IOWA

Reconnaissance phase of a study for five communities and the county in southern Iowa. Studies included identification of public agencies working in the county and their role in area-wide development, present and future role of the Regional Planning Commission, and goals and objectives for the region. In addition, a future work program and housing element were developed for the Commission.

Urban Planning

BEDFORD, OHIO

A city planning study and long-range comprehensive plan for a community of 17,500 in the Cleveland metropolitan complex, including a complete survey of the economic base, population, transportation, land use, and housing. The comprehensive plan covers land use, central business district, community facilities, transportation, utilities, zoning ordinance and map, and subdivision regulations.

EAST MOLINE, ILLINOIS

Development of a comprehensive plan for a community of almost 21,000 in the 310,000 population complex embracing Scott County, Iowa, and Rock Island County, Illinois. The planning program included analyses of the economic base, population, land use, transportation, utilities, schools, recreation facilities, neighborhood and housing studies, and central business district analysis. The plan presented recommendations on land use, community facilities, transportation, annexation, and improvements for the central business district. Administrative measures included zoning, subdivision regulations, preparation of an official map, capital improvements program, and planning administration. A special seminar series on building code and zoning administration was conducted for city employees and appointed board members. Continuing assignments include consultation and advice on the scope and information which the city is required to supply to the State of Illinois in conjunction with a Metropolitan Area Transportation Study. A workable program for community development was prepared.

LIBERIAN INTERNATIONAL AMERICAN CORPORATION AND LIBERIA IRON AND STEEL CORPORATION, NEW YORK, NEW YORK

A multi discipline approach was used for this engagement to develop a master plan for a proposed iron ore mining project in West Africa. Facilities include a new deep water harbor, approximately 150 miles of railroad, mine and processing plant, and two new communities. All facilities are to be located in a section of Liberia which is now virtually uninhabited.

Planning studies included economic and social makeup of expected residents, transportation modes, utilities, housing types and community facilities. The "new towns" are expected to have a combined population of 25,000 persons. Determination of capital costs, timing and sources of project funding, and scheduling of manpower needs were also included in the study.

SPENCER, IOWA

Preparation of a comprehensive development plan to guide the future orderly growth of this rapidly growing community of 10,000 in northwest Iowa. Spencer provides services to a trading area of over 100,000 persons. Special emphasis was placed on study of the downtown area. The scope of planning services outlined in detail a comprehensive approach to physical planning, together with planning administration, zoning controls, and subdivision regulations.

WAPELLO, IOWA

The comprehensive plan for this community of 1,700 persons gave special consideration to economic dependency of the area. An agriculturally oriented community with stable population poses planning problems requiring detailed analysis.

MUSCATINE, IOWA

Long-range comprehensive plan for a community of 22,500 with major emphasis on the central business district and transportation framework.

A Workable Program for Community Development was prepared in conjunction with the implementation programs.

FAIRPORT HARBOR, OHIO

Development of an action oriented plan to revitalize this community of 3,700 in the Cleveland metropolitan area. Community resources were analyzed and a long-range plan prepared to capitalize on high value amenities. A short-range management program was developed.

WASHINGTON, IOWA

Preparation of comprehensive development plan to guide growth of city of 6,000 population which has recently experienced substantial industrial development. The scope of planning called for changes in present development practices in the community and directing of municipal and private investments to meet needs of population change.

SHAKER HEIGHTS, OHIO

This study was concerned with development of a long-range land use program for the central portion of a suburban community of 36,000. The high-value and densely built study area was affected by major traffic arteries and included the municipal governmental complex.

WEST BURLINGTON, IOWA

Comprehensive city plan, including zoning ordinance, subdivision controls, and administrative procedures.

MENTOR, OHIO

Long-range plan for a rapidly developing community of 28 square miles in the Cleveland metropolitan area. County population is expanding rapidly and already exceeds 200,000. Adjacent Cuyahoga County has over 1.7 million persons. Comprehensive planning studies include land use, transportation, parks and open space, and capital improvements.

OSCEOLA, IOWA

Long-range comprehensive development plan for a community of 3,500 in southern Iowa. The studies included analysis and projection of community needs over the next 20 years. Emphasis was placed on the transportation system, land use planning, and annexation policy.

Central Business District

MANDAN, NORTH DAKOTA

Project consisted of a central business district plan and development program. In support of the physical improvement plan, a management program and strategy approach was prepared to utilize various federal loan and grant-in-aid programs. The sequence of priority projects set forth permitted coordinated improvements by public and private investment. In addition to the comprehensive report, a CBD Digest Brochure was prepared to obtain broad public understanding and support.

MUSCATINE, IOWA

General Neighborhood Renewal Plan developed for the central business district and adjoining areas. The study area covered 176 acres and included riverfront recreation, flood considerations, rehabilitation of retail and residential areas, parking and traffic consideration. Land absorption studies and economic analyses were conducted. The GNRP identified problems, types of renewal treatment, financing and relocation of businesses and residents. Gross cost of first project was estimated to be \$2.5 million. Cost of the five projects necessary to renew the study area will exceed \$10.5 million.

FORT MADISON, IOWA

A General Neighborhood Renewal Analysis was developed for this municipality. Over one-third of the city's developed area was analyzed to determine techniques and procedures for renewing and updating business and residential areas. A major highway relocation project influences the 631 acre area. Housing resources for dislocated families was a dominant concern.

BEDFORD, OHIO

A city planning study and long-range comprehensive plan for a community of 17,500 in the Cleveland metropolitan complex, including a complete survey of the economic base, population, transportation, land use, and housing. The comprehensive plan covers land use, central business district, community facilities, transportation, utilities, zoning ordinance and map, and subdivision regulations.

A later study developed a program to provide off-street parking in the central business district.

EAST MOLINE, ILLINOIS

Development of a comprehensive plan for a community of almost 21,000 in the 310,000 population complex embracing Scott County, Iowa, and Rock Island County, Illinois. The planning program included analyses of the economic base, population, land use, transportation, utilities, schools, recreation facilities, neighborhood and housing studies, and central business district analysis. The plan presented recommendations on land use, community facilities, transportation, annexation, and improvements for the central business district. Administrative measures included zoning, subdivision regulations, preparation of an official map, capital improvements program, and planning administration. A special seminar series on building code and zoning administration was conducted for city employees and appointed board members. Continuing assignments include consultation and advice on the scope and information which the city is required to supply to the State of Illinois in conjunction with a Metropolitan Area Transportation Study.

SPENCER, IOWA

Preparation of a comprehensive development plan to guide the future orderly growth of this rapidly growing community of 10,000 in northwest Iowa. Spencer provides services to a trading area of over 100,000 persons. Special emphasis was placed on study of the downtown area. The scope of planning services outlined in detail a comprehensive approach to physical planning, together with planning administration, zoning controls, and subdivision regulations.

ADAMS COUNTY REGIONAL PLANNING COMMISSION AND THE CITY OF CORNING, IOWA

Preparation of a comprehensive plan for the first regional agency established in Iowa. Work included development of base maps; background studies covering economic base, population, land use, transportation, utilities, schools, recreational facilities, housing and central business district analysis; the development of a comprehensive plan for land use, community facilities, transportation and improvements to the central business district of Corning, Iowa. Implementation programs included zoning, subdivision regulations, capital improvements program, and planning administration.

Sewer and Water

FOUNTAIN COUNTY AREA PLANNING COMMISSION, INDIANA

Preparation of a Farmers Home Administration sewer and water plan for this predominately rural county of 18,300. Population, economics, natural resources, land use, and transportation facilities were analyzed as to their effects on short- and long-range sewer and water needs. Cost estimates and implementation priorities were prepared.

WHITE COUNTY AREA PLANNING COMMISSION, INDIANA

Special emphasis was placed on development of a sewer and water system to serve recreation oriented facilities around two lakes in the central portions of the county. A lake area peak population of nine times winter population complicated plan formulation. Both regional and local system improvements were proposed.

TIPPECANOE COUNTY AREA PLANNING COMMISSION, INDIANA

Development of a plan to meet short- and long-range sewer and water needs for a rapidly growing county of 110,000 in western Indiana. The importance of the interrelationship between land development policies and utility extensions was stressed in the study.

MARK TWAIN AND NORTHEAST MISSOURI REGIONAL PLANNING COMMISSIONS

Development of general plans for improvement of water and sewerage facilities in a total of nine counties in Missouri involving over-50 individual communities and rural areas. Regional type developments were considered where local population and economic factors warranted.

JO DAVIESS COUNTY, ILLINOIS

Development of a sewer and water plan in conjunction with a "701" comprehensive planning study for this county of 21,800 persons in northwest Illinois. Special emphasis was placed on integrating sewer and water needs with other facets of community and county development.

Campus Planning

EASTERN IOWA COMMUNITY COLLEGE, MUSCATINE, IOWA

Site planning and design of buildings, utility plans, and supervision of construction on a community junior college for approximately 400 students.

Second phase studies included attendance factors, circulation and parking; design and construction of bi-level classroom, increasing student capacity to 700. Planning continues for ultimate student population requirements.

SOUTHEAST IOWA AREA 16 COMMUNITY COLLEGE, BURLINGTON, IOWA

Site selection studies analyzed seven locations in the Burlington, Iowa, area. Community growth patterns, transportation routes, topography, and utility services were determining factors. Master plan and design of vocational technical and academic facility.

IOWA STATE BOARD OF REGENTS, STATE UNIVERSITY OF IOWA

Site analysis and land use plan for 520-acre tract formerly site of the Oakdale Sanatorium. Facilities included nutritional research, medical research, honors campus, and student housing.

IOWA WESLEYAN COLLEGE, MOUNT PLEASANT, IOWA

This long-range development plan included space and building needs for a small liberal arts college. A subsequent assignment included design of a new library.

LORAIN COUNTY COMMUNITY COLLEGE, OHIO

Our assignment was to conduct site surveys and recommend location for a county junior college in Lorain County, Ohio. Transportation facilities, population growth, and patterns of urbanization were determining factors.

Special Studies

RIVER TERMINAL FACILITY, SOUTHEAST OHIO

Development of economic and feasibility studies leading to the establishment of a multi-purpose river terminal facility on the Ohio River. These studies represent an investigation in considerable depth of specific elements of the county's comprehensive plan--the project was related to regional economics and transportation. Studies were prepared for the Federal Area Redevelopment Administration on behalf of the City of Portsmouth, Ohio, and Scioto County, Ohio.

FAIRFIELD, IOWA

Study and program development of successful annexation in college community of 8,700 in southeastern Iowa. Project included examination of potential areas of annexation, projections of cost and revenues from annexed areas, financial capability of the municipality to support change, and development of public information strategy.

CARROLL COUNTY, IOWA

Report on a regional solid waste management plan for the county. Investigation included refuse collection procedures for municipal and rural areas, recommended areas for sanitary landfills, and organization and financing methods for managing the proposed plan.

CONDOMINIUM HOUSING PROJECT, MAMORA BAY, ANTIGUA, BRITISH WEST INDIES

A preliminary site plan was developed for a condominium housing and resort complex. Planning and design services involved siting apartment units overlooking Mamora Bay, landscaping and coordination of site requirements for water, sanitary sewer, electrical service and roadways.

CITY PLANNING COMMISSION, DAVENPORT, IOWA

Consultation on development programs of the city and advice on the Davenport zoning ordinance.

INDUSTRIAL PARK, EAST MOLINE, ILLINOIS

Detailed studies of street location, lot layout, rail service and utilities for a city-owned 535 acre tract of land. Alternative plans were examined as to their effect on adjacent residential property and the area road system. New zoning standards were developed to control development in the industrial park.

CLINTON COUNTY, IOWA

Development of regional solid waste plan for a service area comprising a population of about 53,000.

HARBOR STUDY, KINGSTON, JAMAICA

An inter-disciplinary team conducted life cycle studies on Kingston Harbor. Land use studies and environmental considerations were presented.

CARBONDALE, ILLINOIS

A comprehensive land use plan was developed for the proposed Cedar Creek municipal water supply reservoir and surrounding lands. Water area of some 2,000 acres and land area of 3,000 acres were studied and evaluated. Land use pattern was established, including areas for recreational, residential, industrial, and commercial development. Administrative and operational opportunities were presented.

HOUSING, KINSHASA, ZAIRE, AFRICA

Planning and design services in Kinshasa, Zaire, involved the layout of a 140 acre, 250 unit residential community for government personnel. Site planning involved the integration of single family housing with apartments, townhouses, commercial shopping area, and recreation and open space facilities. Excessively steep topography required close coordination of roadways and water, sewer, and electrical utilities.

BEDFORD, OHIO

Preparation of a program to provide off-street parking in the central business district of this community of 17,500 in the Cleveland area.

MUSCATINE, IOWA

Twenty year projections of population, housing units, employment, school enrollment, auto ownership, and other factors for sub-areas of the city. The projections provided basic inputs into a transportation plan for this community of 22,500.

ARTIFICIAL ISLAND, NASSUA, BAHAMAS, BRITISH WEST INDIES

A conceptual development plan was executed for this 86-acre, man-made island, created in conjunction with harbor dredging operations. Land use, traffic circulation, landscape treatment, architectural and density controls were recommended.

KNOX COUNTY REGIONAL PLANNING COMMISSION, ILLINOIS

Analysis of a proposed 4,000-acre private recreation-residential development for the Commission. Investigations included evaluation of second home market, community facility needs, utility systems, road system, and commercial activities. Reservation of public open space by the developer was stressed.

THE MIDWEST DEVELOPMENT COMPANY, INC., SILVIS, ILLINOIS

Development of a plan for the future use of 260 acres for industrial, commercial, and residential purposes, including service layout of streets, water lines, and sewers.

SHELBY COUNTY, IOWA

Development of regional solid waste plan for a predominately rural county with a population of about 15,500.

SECO INVESTMENT COMPANY, MUSCATINE, IOWA

Analysis of the development potential of an 80-acre tract. Subdivision design and site planning studies were completed.

INDUSTRIAL SUBDIVISION, ROCK ISLAND COUNTY, ILLINOIS

Economic and site development studies were conducted to determine scale and timing of industrial land need.

CLINTON-CAMANCHE TRANSPORTATION STUDY, IOWA

Stanley Consultants is providing population and land use inputs for this metropolitan transportation study.

RATHBUN REGIONAL PLANNING COMMISSION, IOWA

A project-oriented development program for four southern Iowa counties. This is the first Rural Renewal technical assistance planning project funded in Iowa by the Farmers Home Administration. Details of the planning program encompass future land and facility development around an 11,000-acre Federal reservoir completed in 1968. Over \$25 million have already been spent on this major impoundment. Regional impact was assessed and directed.

RESUME

Timothy J. Warren
1400 South State
Springfield, IL 62704
Telephone: 217/538-4606

Birth Date: 2/6/54
Marital Status: Single

Education: National Student Exchange Program, Resource Geography, 1975,
Oregon State University, Corvallis, Oregon

B.S., Physical Geography and Environmental Planning, 1976,
Illinois State University, Normal, Illinois

Graduate Studies in Energy Management, 1978-79, Sangamon State
University, Springfield, Illinois

Professional Experience:

August, 1979 - Present:

Section Manager, Emerging Technology Development Section, Resource Development
Division, Illinois Institute of Natural Resources

Manager of the Section responsible for the assessment of technologies and
resources within the state which show development and commercialization
potential in energy. Ongoing activity areas include alcohol fuels,
agricultural biomass applications, solid waste-to-energy, low head hydro-
electric, municipal waste oil recovery, industrial waste oil recovery and
biomass production.

August, 1978 - August, 1979:

Program Manager, Biomass Energy Development Program, Alternative Energy
Division, Illinois Institute of Natural Resources

Manager of the program activities in the state to encourage the development
and utilization of biomass as an alternative energy source. Areas of
responsibility included: providing technical assistance and information
to individuals on bioconversion technologies, biomass resources, and
economic feasibility of biomass to energy applications; analyzing and
monitoring programs and policies pertaining to the development of biomass-
derived fuels; and implementing key demonstration projects and research
applicable to biomass development in Illinois. Program activity areas
initiated included: gasohol, ethanol production and utilization, wood
combustion systems, crop residues as an agricultural energy supply, biomass
densification and pelletization, sewage sludge applications to marginal
lands, and silvicultural energy farming.

January, 1977 - July, 1978:

Legislative Analyst, Illinois General Assembly

Provided legislative analyses and supportive research on legislation per-
taining to energy, environment and natural resource areas.

PERSONAL RESUME

Nicholas P. Hall
Rural Route #1
Rochester, IL 62563

31 years old
Caucasian
Married, one child

Telephone 217/493-9896
work 217/785-3316

April 1, 1980 - Present

Employer: Illinois Institute of Natural Resources
Emerging Technology Development Section
Alcohol Fuels Program

Title: Manager

Duties: Manage the development and implementation of the Alcohol Fuels Program for the following areas of responsibility: analyze and implement state and federal policies and programs pertaining to the development of alcohol fuels; establish and maintain local, state and federal alcohol fuels liaison activities; develop technical and financial assistance for the production of alcohol fuels; administer university research projects on alcohol fuels; and monitor alcohol fuels research and development projects and assess impact of alcohol fuels research.

January, 1978 - March 31, 1980

Employer: Illinois Department of Administrative Services
Purchasing Division
Energy Resources Group

Title: Technical Analyst

Duties: Direct research for statewide energy efficient procurement program. Develop and implement energy efficient purchasing procedures and recommendations. Supervise, assign and review the work of a technical staff engaged in complex analyses. Prepare detailed technical and financial reports concerning energy efficiency. Represent the Department of Administrative Services in local, state, federal and private matters pertaining to energy efficient procurement. Provide training on a statewide and national basis for procedures in energy efficient procurement.

September, 1976 - January, 1978

Employer: Illinois Department of Transportation
Bureau of Materials and Physical Research
Chemistry Laboratory

Title: Chemical Technician

Duties: Conduct and report results of complex chemical and physical laboratory analyses on petroleum products.

Education

B.A. in Biological Science, Sangamon State University, 1976

M.A. in Environmental Administration, Sangamon State University, 1980

JOHN H. BEASLEY

PROJECT MANAGER

EDUCATION Texas A & I University--B.A., Political Science.
Texas A & I University--M.A., Public Administration.

PROFESSIONAL SOCIETIES Member--International City Management Association, American Society of Planning Officials, American Public Works Association, and America Water Works Association.

EXPERIENCE Fourteen years' experience in his field.

At present, Project Manager responsible for federal, state, and local government projects in a variety of fields.

Previously served as a local government administrator, as Executive Director of an eight-county regional council of governments in Ohio, and as an advisor to state and local government officials in India. Mr. Beasley has also served both as Stanley Consultants' Principal Management Analyst and as the Head of the company's technical department responsible for highway, rail, port, and airport design and for related transportation analysis efforts.

Professional experience includes extensive work in the management of major highway, water resource, and wastewater facility planning and design projects; municipal and regional water, sewer, and solid waste facility studies; recreation and park facility development for municipalities, state, and federal clients; extensive involvement in EPA 208 and Corps of Engineers' wastewater management studies; and the execution of studies relating to subject areas such as financial and institutional analysis, utilities management, port development, and flood control.

DUANE T. KEXEL

PRINCIPAL ECONOMIST

EDUCATION John Carroll University--B.A., magna cum laude, Mathematics.
University of Wisconsin--M.A., Economics.
University of Wisconsin--Ph. D. course work complete with concentration in econometrics and international economics.

PROFESSIONAL SOCIETIES Member--American Economics Association and Pi Mu Epsilon (Mathematics).

EXPERIENCE Over seven years in a variety of areas in his field. With company since 1973.
Projects have included projective demographic and economic analyses; feasibility studies of domestic and international ports and highways, flood control projects, and recreation developments; socio-economic impact assessments; detailed statistical analyses of flood damage; public opinion polling; energy studies; and electric load forecasting.
Professional experience has included work in international economics, linear programming, econometrics and statistics, modeling and simulation, cost-benefit analysis, tax impact studies, rate determinations, location studies, and economic evaluations of alternatives for a broad spectrum of proposed projects.

PROFESSIONAL RECOGNITION Author of papers entitled "An Empirical Analysis of Unemployment, Its Composition and Causes," "Monetary vs. Fiscal Policy, Anderson-Jordan Revisited" and "Estimation and Evaluation of the Klein-Goldberger Model of the U.S." presented at various workshops for educational computer usage.

DUANE T. KEXEL

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Awarded a National Science Foundation Grant for development of instructional manuals on the use of the computer in economic research.

Assisted on study of the economic impact of a disease eradication program for Santa Lucia.

Assisted with the development of materials used in conjunction with a computer aided instructional system to improve efficiency in undergraduate education.

NORMAN B. SMITH

ASSOCIATE CHIEF CHEMICAL ENGINEER

EDUCATION University of Illinois--B.S., Chemistry.

University of Illinois--B.S., Chemical Engineering.

REGISTRATION Registered Chemical Engineer--Iowa and three other states.

PROFESSIONAL SOCIETIES Member--American Chemical Society, American Institute of Chemical Engineers, American Association for Advancement of Science, Society of Industrial Microbiologists, National Society of Professional Engineers, and the Iowa Engineering Society.

EXPERIENCE Twenty-six years of experience in his field. With company since 1966.

Associate Chief Chemical Engineer responsible for technical reports and design of projects concerning industrial process and pollution abatement. Available for assistance and consultation on problems of a chemical and environmental nature. Carries Project Engineer responsibilities on industrial-related projects.

Projects include manufacture and recovery of industrial fermentation products, production of corn starch and alcohol, studies and design of water pollution abatement systems for waste from steel and coke industries, studies and design of air pollution abatement systems for process and power industries, studies and design of industrial utilities systems including steam generation, and pilot plants for commercial manufacturing facilities.

Professional experience includes planning and feasibility studies in West and Central Africa and U. S.; reports; design; consultant on starch and milling industry problems; air and water pollution abatement; and successive responsible positions during 14 years



with a major midwest grain processing company as Fermentation Plant Superintendent, Recovery Plant Superintendent, and Research and Development Engineer.

PUBLICATIONS Several articles published in trade journals.

Author of "A Multiple Discipline Approach to Pollution Abatement in the Steel Industry," presented before Scandinavian Congress of Chemical Engineering, Copenhagen, Denmark.

Author of "Sources and Treatments of Cyanides in Iron and Steel Industry Wastewater," and "Experience with Evolutionary Operations," presented before European Congress of Chemical Engineering, Frankfurt, Germany.

PROFESSIONAL

RECOGNITION Listed in "Who's Who in Engineering."

LANGUAGES French and German--useful reading and speaking knowledge.

W. A. LIEGOIS

SENIOR PROCESS ENGINEER

EDUCATION Vanderbilt University--B.E., Chemical Engineering.

Vanderbilt University--M.S., Chemical Engineering.

PROFESSIONAL

SOCIETIES Member--American Institute of Chemical Engineers.

EXPERIENCE Seven years' experience in his field.

At present, Senior Process Engineer in Industrial Process Department of Process and Utilities Group.

Projects include design of air pollution abatement systems for process and power industries, design of solid waste disposal systems, and design of heat recovery systems.

Professional experience includes R&D engineer involved with electro-chemistry and packaging; process engineer in chemical processing plant involving waste heat recovery, air and water pollution control, system debottlenecking and operating problems, and plant start-ups; environmental engineer working with state and federal agencies; and project engineer responsible for specifying, purchasing, and installing major chemical equipment. Process engineering experience in the manufacture of propylene oxide, tert-butyl alcohol, benzene, styrene, hydroperoxides, and vinyl acetate.

KENNETH C. LEIMKUEHLER

HEAD, PROCESS AND UTILITIES GROUP

EDUCATION University of Missouri--B.S., Chemical Engineering.
Graduate courses in Operations Research, Computer Programming, Industrial Statistics, and several management courses.
Alexander Hamilton Institute--Modern Business Methods (M.B.A. Program).

REGISTRATION Registered Chemical Engineer--Iowa and seven other states.

PROFESSIONAL SOCIETIES Member--American Institute of Chemical Engineers and National Society of Professional Engineers.

EXPERIENCE Nineteen years of experience in his field. With company since 1969.
At present, Head, Process and Utilities Group.
Projects include studies, design, engineering, and installation of buildings and equipment including materials handling, mechanization and automation equipment, oil expellers, driers, coolers, distillation columns, filters, large hydraulic presses, and high temperature equipment; plating equipment; resin production; molding equipment; large steam boilers; steam accumulators; coal gasification; large refrigeration facilities; air and water pollution control equipment for numerous industries, municipalities, and NASA installation; waste disposal equipment; and sludge and refuse recovery or recycle, and incineration.
Professional experience includes studies and reports, design, construction management, former positions of Chief Plant Engineer, Quality Control Engineer and Facilities Engineer, Design Engineer, Design Manager, and Plant Engineer.

PUBLICATIONS Author of several papers in various municipal and industrial fields.

LANGUAGE German--Useful reading knowledge.

THOMAS W. WOOD

ECONOMIST

EDUCATION Virginia Polytechnic Institute & State University--B.A., Economics.

PROFESSIONAL
SOCIETIES Member--American Economics Association.

EXPERIENCE Nine years of government and consulting experience.

Projects have included forecasts of economic parameters for a wide range of applications, including major highway, airport, utility, and port development projects; design and specification of regional econometric models for impact analysis; and design and implementation of extensive sample surveys.

Financial experience includes project management of several utility rate and bonding studies and input to acquisition investigations. Operations research projects include simulations of recreational boating activity and the U.S. Army system of facility supply.

Has developed information systems for regional planning and impact assessment applications.

JOHN SAYLES

ENVIRONMENTAL CONSULTANT

EDUCATION University of Michigan--B.A., Geography.

PROFESSIONAL SOCIETIES Member--American Institute of Certified Planners, and American Planning Association.

EXPERIENCE Twenty years of experience in his field. With company since 1963.

At present, serves as study manager on environmental projects and provides consultation on environmental engagements within Power Division.

Projects include site selection studies for major power plants in Iowa, Florida, and Wisconsin; preparation of environmental assessments for a coal-fired plant and associated transmission lines in Alaska; supervision of environmental studies for transmission lines and power plants in Ohio and Iowa; and development of land use, housing and population projections as major inputs to long-range system plans for utility clients in the midwest.

Professional experience includes project administration; environmental studies, transportation planning, public management studies, land use planning and comprehensive master planning; served as head of company environmental science and development planning departments.

T I M J. W E Y E N B E R G

ENVIRONMENTAL ANALYST

EDUCATION University of Wisconsin--B.S., Zoology.
Southern Illinois University--M.A., Biology.

PROFESSIONAL
SOCIETIES Member--Ecological Society of America, North American Benthological Society, and Sigma Xi.

EXPERIENCE Experience in environmental impact assessments and applied biology.
Six years of experience in his field.

Project experience includes environmental analysis and impact assessment of electrical and natural gas transmission line corridors, construction monitoring of electrical power generating facilities, baseline studies of a proposed coal-fired electrical generating plant and ash/FGD sludge disposal facilities, flood control projects, harbor maintenance, wastewater treatment plants for domestic and industrial purposes, 201 Facilities Plans, wetlands development, and a variety of other water resources studies.

Representative environmental baseline studies include water quality and aquatic biology surveys of major U.S. rivers and small streams, lakes and reservoirs, and coastal systems; terrestrial surveys of midwestern and eastern communities; endangered and threatened species surveys; habitat evaluation; and successional trend analysis.

Other experience includes the preparation of 316 demonstration study plans, assessment of effects of toxic substances on terrestrial animal species; monitoring for trace organics in aquatic systems; preparation of expert testimony; conceptual modeling of ecosystems; and bioaccumulation of radioactive elements.

PUBLICATIONS Numerous publications, reports, and program plans relating to applied biology, environmental impact assessment, and assessment methods.

APPENDIX 'A'
 Companies Contacted Regarding Interest And
 Participation in Industrial Steering Committee

Kraftco Corporation Galena, IL	Boden Products Inc. Franklin Park, IL	Pillsbury Co. Inc. Springfield, IL
Kraft Inc. Glenview, IL	Del Monte Corporation Rochelle, IL	Lauhoff Grain Company Danville, IL
Campbell Soup Co. Chicago, IL	Del Monte Corporation Mendota, IL	IL Cereal Mill Paris, IL
Griffith Laboratorie Chicago, IL	Green Giant Co. Belvidere, IL	Archer-Daniels-Midland Decatur
Thomas J. Lipton Inc. Franklin Park, IL	Mrs. Grass Inc. Bellwood, IL	J. R. Short Milling Co. Kankakee, IL
Joan of Arc Co. Hoopeston, IL	Borden, Inc. Northbrook, IL	Dixie Portland Flour Chicago, IL
The Suters Food Inc. Sycamore, IL	Plochman Inc. Chicago, IL	Peavey Co. Alton, IL
Vanee Food Company Melrose Park, IL	Re-Mi Foods Inc. Arlington Heights, IL	Quaker Oats Company Chicago, IL
Joan of Arc Company Peoria, IL	Sunstar Foods, Inc. Streator, IL	Nabisco Inc. Naperville, IL
Kraftco Corporation Mattoon, IL	Claussen Pickle Co. Inc. Woodstock, IL	General Mills Inc. Chicago, IL
Consolidated Foods Co. Chicago, IL	Custom Food Products Chicago, IL	Quaker Oats Co. Danville, IL
Milford Canning Co. Inc. Milford, IL	Pet Incorporated Arlington Heights, IL	General Mills Inc. West Chicago, IL
Libby McNeill & Lib Chicago, IL	Consolidated Food Co. Deerfield, IL	J. W. Allen & Co. Chicago, IL
Conway Import Co. Inc. Franklin Park, IL	Anthony J. Pizza Food Chicago Heights, IL	Brownie Special Prod. Gardner, IL
Borden Inc. Chicago, IL	Infra-Red Foods Corp. Oak Park, IL	Gilster-Mary Lee Corp. Steeleville, IL
Home Juice Co. Inc. Melrose Park, IL	Millers Pre-Pared PO Blue Island, IL	Gilster-Mary Lee Corp. Chester, IL
Joan of Arc Company Princeville, IL	On-Cor Frozen Foods Chicago, IL	Tolona Pizza Product Chicago, IL
A. E. Staley Mfg. Co. Chicago, IL	Rolar Foods, Inc. Arlington, Heights, IL	Lizio Foods Des Plaines, IL

CPC International Inc. Argo, IL	Swift & Co. Bradley, IL	Golden Grain Macaroni Oak Lawn, IL
CPC International Inc. Pekin, IL	Criterion Molded Pro. Lemont, IL	Foulds, Inc. Libertyville, IL
Kraftco Corp. Danville, IL	SCM Corp. Joliet, IL	Bernard Food Industr. Evanston, IL
Allied Mills Inc. Peoria, IL	A. E. Staley Manufacturing Champaign, IL	Standard Brands Inc. Pekin, IL
Perk Foods Co. Inc. Park Ridge, IL	Chicago Shortening Co. Chicago, IL	Jays Foods Inc. Chicago, IL
General Foods Corp. Kankakee, IL	Re-Mi Foods Inc. Arlington Heights, IL	Elgin-Honey Hill Corp. Chicago, IL
Jim Dandy Co. Inc. Monmouth, IL	Carling National Bre. Belleville, IL	Kelly Food Products Decatur, IL
Quaker Oats Co. Inc. Rockford, IL	Pabst Brewing Co. Peoria, IL	Evans Food Products Chicago, IL
National Pet Food Co. Chicago, IL	Falstaff Brewing Co. Chicago, IL	Borden Inc. Des Plaines, IL
Quincy Soybean Company Quinch, IL	Fleischman Malting Co. Chicago, IL	American Pouch Foods Chicago, IL
SCM Corporation Chicago, IL	Horns Poultry Inc. Mattoon, IL	B. Heller & Company Chicago, IL
Continental Grain Co. Taylorville, IL	American Distilling Pekin, IL	General Foods Corp. Chicago, IL
A. E. Staley Manufacturing Decatur, IL	Joyce Beverage of IL Joliet, IL	Stokley-Van Camp Co. Dixon, IL
Central Soya Company Gibson City, IL	Distillers Co. Ltd. Plainfield, IL	Lauritzen & Co. Inc. Wheeling, IL
Kraftco Corp. Champaign, IL	Hiram Walker & Sons Peoria, IL	Frito-Lay Inc. Elmhurst, IL
Beatrice Food Co. Elgin, IL	James B. Beam Distil. Chicago, IL	Standard Brands Inc. Chicago, IL
CPC International Inc. Chicago, IL	Barton Brands Ltd. Chicago, IL	The Jel-Sert Company West Chicago, IL
Hunt-Wesson Foods Inc. Chicago, IL	Hygrade Food Product Chicago, IL	Swift & Company Chicago, IL
Swift & Co. Kankakee, IL	D. Amico Macaroni Co. Stager, IL	National Tea Packing Chicago, IL

D C A Food Industries
Melrose Park, IL

Appetizers And Inc.
Evanston, IL

Orval Kent Food Co.
Chicago, IL

General Foods Corp.
Chicago, IL

H. J. Heinz Co.
Roselle, IL

Mr. C. Enterprises Inc.
Waukegan, IL

Miles Laboratories Inc.
Roselle, IL

D C A Food Industries
Millstadt, IL

Victory Spud Service
Chicago, IL

Frito-Lay Inc.
River Grove, IL

Azteca Corn Products
Chicago, IL

Landshire Fd. Systems
Belleville, IL

Fairmont Foods Company
Rockford, IL

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